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APPENDIX I

Approved For Release 2003/12/04 : CIA-RDP80-00926A003100040001-4

United States 1945

APPLICATION OF THEORY OF ABSOLUTE REACTION VELOCITIES TO CREEP OF METALS, Rs. Modern, Phys. V. 17, pp. 48-49, June, S. Dushman.

DATA

United States 1945 THEORY

CREEP OF METALS James L. Erickson, Light Metal Age, 3 (1) pp. 22-23, 26-27.

A general discourse on the phenomena of creep. Theories put forward by various investigators are reviewed and a bibliographs of 34 references is appended.

United States 1945 Theory (?)

TENSILE DEFORMATION, J. H. Hollomon, Trans. AIMME, Vol 162.

United States 1945

CREEP PROPERTIES OF SOME BINARY SOLID SOLUTIONS OF FERRITE, Charles R. Austin, C. R. St. John and R. W. Lindsay, Metals Tech. V12, Aug. TP. 1836, 22 pp.

Describes the results of isolating one microstructural phase, namely ferrite, and studying its creep characteristics in both the unalloyed and alloyed conditions. This should aid in establishing to a large degree the importance of ferrite in the creep behavior of steels consisting of the previously mentioned ferrite-carbide aggregate.

United States 1945

CREEP PROPERTIES OF COLD DRAWN ANNEALED MONEL AND INCONEL, B. B. Betty, H. L. Eiselstein, and F. P. Uston, Jr. Trans. Amer. Inst. Min. Met. Eng. 161 pp. 441-452.

Creep data have been obtained for cold-drawn and annealed Monel and Inconel at temperatures between 800° and 1100°F. Inconel has approximately twice the load-carrying capacity of Monel at any temperature, but Monel compares favourably with many low-alloy steels so far as creep performance is concerned. The tensile and Izod properties of the materials at room temperature after creep testing are recorded and a type of round Izod test-piece suitable for these alloys is described.

United States 1945

METALS AND ALLOYS, V. 21, P. 766, March, H. Adenstedt.

Creep properties of aluminum.

United States 1945

CREEP CHARACTERISTICS OF A PHOSPHORIZED COPPER, H. L. Burghoff and A. I. Blank, Trans. Amer. Inst. Min. Met. Eng. 161, pp. 420-438.

The creep characteristics of copper wire (0.0008% of phsophorus(as annealed to a grain size of 0.013 mm. and as drawn to 84% reduction, are reported for a temperature of 300°, 400° and 500°F. The creep-resistance of the drawn wire decreases as recrystallization takes place.

Data on
see below

United States ~~1947~~ 1945

A METALLURGICAL INVESTIGATION OF A LARGE FORGED DISK OF LOW-CARBON N-155 ALLOY, . W. Freeman and H. C. Cross, National Advisory Committee for Aeronautics Wartime Report W-103, Dec. 1945, 41 p.

The alloy contained 21.66% Cr, 19.40% Ni, 19.02% Co, 2.76% Mo, 1.90% W, 1.74% Mn, 0.79% Cb, 0.37% Si, 0.15% C and 0.14% N_2, and was studied in the hot forged and stress-relieved condition by means of stress-rupture and creep tests for periods up to 2000 hr. at 1200, 1350, and 1500°F. Short-time tensile test, impact test, and time vs. total deformation characteristics.

Data on non ferrous metals

United States 1945

APPLICATION OF NON FERROUS METALS AND ALLOYS IN STRESS DESIGN, J. J. Kanter, Trans. Amer. Inst. Min. Met. Eng. 161 pp. 402-417,

The creep characteristics of non-ferrous metals are briefly summarized, and a bibliography and series of abstracts dealing with the topic are appended.

United States 1946

SUPER ALLOYS FOR HIGH TEMPERATURE SERVICE, Harold A. Knight, Materials and Methods, 23, pp. 1557-1563.

A general survey, including brief references to nickel, cobalt, and chromium base alloys.

United States 1945

TENSION TESTS AT CONSTANT TRUE STRAIN RATES, C. W. MacGregor and J. C. Fisher, J. applied Mech. 12, pp. A217-227.

Tension tests of the true stress-strain type are reported for which the true strain rate is maintained constant throughout each test. Several metals (steel and brass) are investigated under testing temperature ranging from -183°C to 665°C. The influence of temperature and strain velocity on the true stress-strain properties is described. A single variable called the velocity-modified temperature is used to represent the combined influences of true strain rate and testing temperature.

United States 1945

PROPERTIES OF SOME CAST COPPER-BASE ALLOYS AT ELEVATED TEMPERATURES, H. E. Montgomery, Trans. Amer. Inst. Min. Met. Eng. 161, pp. 455-463.

A review of existing literature on the high-temperature creep properties of cast copper-base alloys.

United States 1945

SYMPOSIUM ON CREEP OF NON FERROUS METALS AND ALLOYS, H. L. Schumacher, and E. E. Burghoff, (presiding). AIMME, Trans. 1945, V. 161 pp. 401-477.

United States 1945

CREEP PROPERTIES OF SOME ROLLED LEAD ANTIMONY ALLOYS, A. A. Smith, Jr. and H. E. Howe, Trans. Amer. Inst. Min. Met. Eng. 161, pp 472-475.

Alloys of lead containing antimony, bismuth, and copper were cast and rolled to 0.1 in. thickness; 16 in. lengths of this material were then clamped together and creep tests conducted on the specimens at 30° and 100°C.

18-8 weld plate

United States 1945

A NOTE ON THE PHYSICAL PROPERTIES OF AN AUSTENITIC WELD METAL AND ITS STRUCTURAL TRANSFORMATION ON STRAINING, K. Winterton, Welding Journal, V. 24, May, pp. 308s-310s.

Mechanical tests at elevated temperatures on composite 18-8 weld-plate tensile specimens, showed that the tensile strength, yield strength, and hardness declined with increased testing temperatures. Effect of prior heat treatment at 850°C. in causing increased tensile strength, and decreased uield strength, decreased with testing temperature and was not apparent above 150°C. Microscopic examination showed a breakdown of dendritic regions to a light-etching alpha-constituent, and the formation of lines and blocks of a deep-etching alpha-constituent, probably due to uneven straining.

United States 1945

METALS FOR HIGH TEMPERATURE SERVICE, Industrial Heating, V. 12, July pp. 1209-10, 1214, 1230.

Ferrous metals for applications involving resistance to high temperatures, and creep, recovery and relaxation of oxygen-free copper.

United States 1945

CREEP RESISTANT ALLOY STEELS, Iron Age, V. 156, Aug. pp. 58-63.

Behavior of alloy steels at prolonged elevated temperatures shows that the addition of molybdenum to steel imparts high heat strength. Vanadium has a similar reaction in steel alloys but to a lesser degree. Comparative effect of other alloying agents like chromium, nickel, manganese and silicon on physical properties is also included.

United States 1945

Creep Data on Die-Cast Zinc Alloy, E. H. Kelton, and B. D. Griesinger, Trans. Amer. Inst. Min. Met. Eng. 161, pp. 466-471.

A test method involving the bending of a die-cast zinc alloy beam is described and beam creep-test data at 25°C and various stresses for a zinc die-cast alloy are presented.

United States 1945

NEW MACHINES FOR CREEP AND CREEP RUPTURE TESTS, M. J. Manjoine, Trans. Amer. Soc. Mech. Eng. 67, pp111-116.

Two new creep-rupture machines are described. One, a lever-arm creep machine, combines the compactness of a multiple unit with the flexibility of an individual one. Each of the eight specimens in the machine is equipped with an extensometer which gives the direct reading of the extension on a counter; these counters are photographed periodically. The other machine loads the specimen through a stiff spring and records a continuous creep-to-rupture curve without the use of an extensometer on the specimen. Occupying an area of 15x15 in., this latter machine has a capacity of 10 tons. It can also be used for making short-time tensile tests, constant-strain-rate tests, and relaxation tests.

England 1945

EFFECT OF ALPHA RAY BOMBARDMENT ON GLIDE IN METAL SINGLE CRYSTALS, E. Andrade, Nature, 156, pp. 113-114.

Bombarding stressed single crystal wires of Cd with alpha rays from a strong polonium source, deposited on the inside of a nickel cylinder 1 cm. long, which is split longitudinally so that it can be made to surround the wire. The alpha-particles, which penetrate about .005 mm. into the metal, cause considerable local disturbance, but do not produce appreciable bulk heating. The temperature at the axis of the wire does not exceed .01°C.

When a wire is stressed .05% per min., bombardment with alpha-particles causes the rate of flow to increase to several times the value which obtained before the bombardment p 5 times in one particular case - although the wire was bombarded over only one third of its length. The wire had been extended by about 1% when the bombardment was initiated. In the case of another wire which had been extended 2.6% of its length, and was increasing its length at a rate of .21% per minute, bombardment increased the rate by about 3 times.

The greater the preliminary extension, the smaller the effect of alpha-particles, until 12% of extension, no effect will be seen.

Glide on particular planes can be initiated by alpha-ray bombardment, and hence that initiation of glide takes place from the surface. Once a particular plane is active, glide continues at a rate independent of the surface distrubance, is shown by the fact that bombardment does not affect the rate after large preliminary strain when, presumably, all suitable glide planes are in action. The alpha-particle bombardment is, then, a useful index to show whether glide is taking place by the activation of new glide planes or is continuing on planes already in action.

France 1945 11+00R-1

A COMPARISON OF SOME CARBON STEELS ON THE BASIS OF VARIOUS CREEP LIMITS, A. E. Johnson and H. J. Tapsell, Institution of Mechanical Engineers Proc. V. 153, War Emergency Issue No. 6, p. 169-179.

Report has been prepared with a view to determining whether any relationship exists between the results of the various short-time and long-time creep tests, which will permit the use of short-time tests, not merely as a means of separating good from bad steels, but also as the basis of design stresses intended to give satisfactory performance of the steel over working periods of considerable duration.

England 1945

SOME ENGINEERING PROPERTIES OF NICKEL AND HIGH NICKEL ALLOYS, B. B. Betty and W. A. Mudge, Mech. Eng., 67, (2), pp. 123-129.

Eighteen high-nickel corrosion-resisting and heat-resisting alloys were examined. All showed good mechanical properties, as evidenced by a high ratio of strength to ductility over a wide range of temperatures. Useful non-magnetic properties of six of these alloys are summarised. The electrical resistivity of most of the alloys is given, and the special use of two alloys for electical-heating units is indicated.

England 1945

CREEP PROPERTIES OF STEELS UTILIZED IN HIGH PRESSURE AND HIGH TEMPERATURE SUPER-HEATER AND STEAM PIPE PRACTICE. PART II: 0.5% MOLYBDENUM STEELS, H. J. Tapsell and R. W. Ridley, Institution of Mech. Engineers Proc. V. 153, War. Emergency Issue No. 6, pp. 181-192.

Creep properties of carbon-molybdenum steels in the form of a superheater header, superheater tube, and steam pipe manufactured for service at temperatures above about 450°C. Data for the estimation of stress-temperature relationships for from 0.1 to 0.5% creep in various periods up to 100,000 hrs.

England 1948 Equip Data on Be-Cu springs

THE "SET TEST" ELASTIC LIMIT, A. C. Vivian, Harold G. Williams, Metallurgia 32 p. 152.

W. describes the "set test" method using the electron micrometer for evaluating the material and heat-treaments for beryllium-copper precision springs, and states that, no matter how low the stress, there is some set, although for very low stresses it may be beyond the sensitivity of the measuring instrument. For such stresses tests are carried out at a load below the "set test" elastic limit and a logarithmic drift or room-temperature creep curve is obtained over a period of 100 hr. The rate of drift obtained is used to evaluate the stability of the spring material in relation to the retention of calibration in instruments, as when springs are deflected within the usual elastic limits there are three elements in the subsequent strain, an elastic deflection, a permanent set not recoverable, and a drift or creep with time under load that is recoverable.

1945

BIOS Report No. 396

Dulcan
Al-
alloy

ITALY 1945

PROPERTIES OF A NEW ALLOY OF ALUMINUM FOR THE FOUNDRY AND PLASTIC WORKING(DSN), C. Panseri (Alluminio, 14 (9/12), pp 76-90 (in Italian).

P. describes the preparation, heat-treatment, structural properties, mechanical properties (static and dynamic), and corrosion-resistance of a new aluminum alloy, which has been thoroughly investigated in the Experimental Institute of Light Metals, Novara, Italy. The alloy, called DSN, has the following chemical composition: copper 2-4, iron 0.5-1.8, silicon 0.4-2, magnesium 0.2-1.2, titanium 0.025%, aluminum remainder, and is similar in most respect to Duralite, having the additional advantage of containing no nickel. Heat treatment gives it a fatigue resistance higher than that of Duralumin, and it has a high heat-resistance. Anoidc or chemical oxidation, followed by varnishing, will protect it against corrosion. It is particularly useful for the fabrication of automobile parts subject to heat.

Switzerland 1945 THEORY

Data on Sn-Cd + steel

BRITTLENESS AND TOUGHNESS OF METALS AT HIGH TEMPERATURES (TIN CADMIUM ALLOYS AND STEELS), W. Siegfried, Schweiz Archiv. 11, (11, 1945, 1-16 (2) 43-61).

I. Attempt to correlate brittle behavior with some other mechanical property and size and shape of notch. Data on Tin-~~and~~Cadmium.

II. Creep tests with both smoth and notched specimens of steel, attempt to correlate with Tin-Cadmium. Apparently metallurgical factors precluded good correlation.

Russia 1945 Theory

VISCOUS FLOW OF CRYSTALLINE BODIES UNDER THE ACTION OF SURFACE TENSION, J. Frenkel, J. Physics USSR, 9, pp 385-391 (In English),

It is suggested that the viscous flow usually attributed to amorphous bodies, which occurs by the motion of a small number of holes or cavities, may also take place in crystalline substances. In the latter case flow would proceed by the diffusion under stress of vacant sites of the crystal lattice. This process is distinct from plastic deformation. The conception is developed mathematically, and applied to the rate of welding of crystalline powders, at temperatures below their melting points, into a crystalline body. The development of crystal faces on the surface of a spherically ground single crystal is also discussed from the same point of view, the common factor in each case being the reduction in surface energy caused by the change.

[redacted]

Russia 1945 THEORY

THE RELATION OF THE SHAPES OF THE CURVES OF STATIC AND IMPACT STRENGTHS TO PHYSICO-CHEMICAL PROCESSES IN ALLOYS, L. M. Pevzner, Izvest. Akad. Nauk SSSR Tekhn 212-218, C. Abs. (1946) 40 2429. (in Russian)

A discussion of the mechanical properties of alloys in relation to their chemical composition, conditions of thermal treatment, and the effect of cold and hot deformation.

Russian 1945

THE MECHANICAL PROPERTIES OF COPPER AT HIGH TEMPERATURES, Bobylev. A.A. and Chipizhenko, Tsvet. Metally, (3) pp. 62-65 (in Russian).

Annealed wires, 6 mm. in dia., were tested at three rates of extension (1, 20 and 300 mm/min.) at temp. from 20°C to 900°C. With increase in the rate of extension, the strength and plasticity of copper become greater. The deleterious effect of the ambient atmosphere is connected with its action on the grain boundaries, which results in the formation of intercrystalline cracks and leads to a sharp decrease in plasticity.

EWVP

Russia 1945

NEW TESTING MACHINES OF THE TsNIITMASh TYPE, I. V. Kudryavtsev, Zavod. Lab. 11 pp. 209-214 (In Russian).

New machines for the tensile testing of metals as described.

United States 1946 THEORY

PLASTIC FLOW OF METALS, J. H. Hollomon and J. D. Lubahn; Physical Review, V. 70, No. 9/10 p. 775.

A general relation connects all the variables of plastic flow;

$$\sigma = C\left(\alpha/\alpha_0\right)^{DT} \epsilon^{\left(E - FT \ln \alpha/\alpha_0\right)}$$

where α_0 C, D, E, and F are constants of the material; σ, ϵ, α, and T are stress, strain, strain rate and temperature respectively.

This equation can be rewritten in logarithmic form:

$$\frac{\ln\sigma - \ln C - E\ln\epsilon}{F\ln\epsilon - D} = -T\ln\alpha/\alpha_0$$

by comparing it to the relation between strain rate and temperature; the equation is Q/R = $-T\ln \alpha/\alpha_0$ where Q is a function of stress and strain, and R is the gas constant. Q should vary linearly with the logarithm of the stress. This relation differs fundamentally from those of Bekker, Kauzmann, and Dushman. The relations in which the logarithm of the stress varies directly with the temperature, are confirmed by replotting data obtained by Nadai and Manjoine.

The equation has important applications in the problem of creep and in the theory of plastic flow.

United States 1946 THEORY

THE MECHANICAL EQUATION OF STATE, J. H. Hollomon, Metals. Tech .3, No. 6, AIMME, Inst. Metals. Div. Tech. Publ. No. 2034 9pp.

United States 1946 Theory!

A VELOCITY MODIFIED TEMPERATURE FOR THE PLASTIC FLOW OF METALS, C. W. MacGregor and J. C. Fisher; Jour. of Applied Mechanics, V. 13, No. 1, Mar. p. A-11.

Based on the work of Eyring and others relating to the creep problem, a velocity-modified temperature is developed for representing by means of a single variable the combined effects of strain rate and temperature on the stress reaction in a tension specimen. Available data are analyzed, indicating that the velocity-modified temperature is equally applicable to the tension tests conducted at both slow and rapid rates and to the creep test. The data also indicate that the stress reaction, corresponding to tests at very slow and very rapid rates of deformation, may be found from tension tests at moderate strain rates and appropriately raised or lowered temperatures.

United States 1946 THEORY

PLASTIC FLOW, CREEP AND STRESS RELAXATION - I PLASTIC FLOW, II CREEP, III CREEP AND ELASTIC AFTER-EFFECT, Charles Mack; Jour Applied Physics, V. 17, No. 12, pp. 1086-1107.

I. Plastic Flow - Plastic substances are considered to be composed of units of flow with various yield values. Using Burger's model as a basis, several equations for plastic flow are derived. The most outstanding one gives the stress as a power function of the strain rate, or $S/S_o=(V/V_o)^b$ in which b is a constant, S_o and V_o are constants with dimensions of stress S and strain rate V. This equation is applicable to systems in which the structural elements remain in a high degree of disorder. In systems possessing a high state of order under stress, the equation $\exp(S/S_o) = \exp(V/V_o)^b$ appears to be applicable.

II. Creep - Creep is defined as a mechanism of deformation for systems which have a curvilinear relationship between stress and strain rate, and a curvilinear relationship between strain and time at constant stress.

The relaxation of stress at constant strain is discussed. It is shown that the stress relaxation depends upon the history of the substance under test. Thixotropy is work-softening.

III. Creep and Elastic After-Effect - The elastic after-effect is the phenomenon in which deformations recover, as a function of time, on unloading. The relation between strain and time in such systems, and the process of stress relaxation at constant strain are discussed. Equations given in connection with plastic flow, creep due to work-hardening, thixotropy, and creep in combination with elastic after-affects, are applicable to metals, clay soil, food products, acrylic acid polymeride, polyvinyl chloride, cellulose acetate, manila ropes, paper laminates, phenolic molding compounds, rubber, asphalt and bituminous pavements.

United States 1946 Theory

QUANTITATIVE TREATMENT OF THE CREEP OF METALS BY DISLOCATION AND RATE PROCESS THEORIES, A. S. Nowick and E. S. Machlin, National Advisory Committee for Aeronautics, Report No. 845, 10 pps.

An equaion for the steady-state rate of creep is derived by applying the theory of dislocations to the creep of pure metals. The form of this equation is in agreement with empirical equations describing creep rates. The theory was also used to predict the dependence of steady-state rate of creep on physical constants. Good agreement with literature data for pure annealed metals was obtained.

United States 1946 T[illegible]

DEFORMATION IN RELATION TO TIME, PRESSURE AND TEMPERATURE, P. G. Nutting, Jour. Franklin Inst., V242, No. 6, pp. 449-458.

Generalized linear logarithmic relations between deformation, temperature and pressure are derived from the equations defining compressibility and thermal expansivity, and are shown to apply to the three stages of deformation. Gibb's thermodynamic potential is shown to lead directly to a simple and exact expression for the energy of deformation within any one phase. Thermodynamic relations governing elastic and viscous behavior are developed for both single and multiple phase materials. The equations are checked against experimental data on steel tape, which includes thermal and relaxation observations.

Data on alloy steels

United States 1946

STRESS RUPTURE CHARACTERISTICS OF VARIOUS STEELS IN STEAM AT 1200°F, J. T. agnew, G. A. Hawkins, and H. L. Solberg; Trans. ASME, V. 68, p. 309.

Small tensile specimens made from low-carbon, carbonmoly, 2-1/4 Cr- 1 Mo, 5 Cr-Mo-Si, 9 Cr-Mo-Si, 12 Cr, 18 Cr-8 Ni. 25 Cr-20 Ni, and 5 Cr-Mo-Ti steels were placed in a steam reaction chamber at 1200°F, and stressed in tension for periods of time ranging from 10 hr. to 7700 hr. Data were taken on time to rupture, elongation, reduction in area, depth of scale layer, effect of type of flow, and type and angle of fracture. A photomicrographic study was made of the rupture specimens. The straight-line relationship between stress and time to rupture on log-log co-ordinates postulated by White, Clark and Wilson for tests in air also holds for steam tests.

United States 1946

SUPER-ALLOYS FOR HIGH TEMPERATURE SERVICE IN GAS TURBINES AND JET ENGINES - A SYMPOSIUM, F. Badger, H. Cross, C. Evans, Jr., R. Franks, R. Johnson, N. Mochel, and G. Mohling: Metal Progress, V. 50, No. 1, July, pp. 97-122.

This is a report of a round table discussion on the materials for gas turbines and jet engines. The compositions, the operating characteristics, and the metallurgical aspects are thoroughly discussed. Many improved super-alloys for high temperature service are listed. Data are tabulated on the results of creep, stress-rupture and short time tensile tests; materials tested include both the forged and the cast alloys, and are of the cobalt-chrome type, and of the iron base type. Test temperatures ranged up to 2000°F. The cobalt chrome alloys have the better short time properties, while the iron base alloys are generally better for longer service. Data on the fatigue properties are included.

Data on
Ni-base alloy
+
Co-base alloy

United States 1946

METALLURGY OF HIGH-TEMPERATURE ALLOYS USED ON CURRENT GAS TURBINE DESIGNS, F. S. Badger, Jr., and W. O. Sweeny, Jr. Symposium on Materials for Gas Turbines (Amer. Soc. for Testing Mat.) p. 99-112, dis. p. 121-128.

The two high-temperature alloys most widely used during World War II were not developed as a result of the war program, but were available at the beginning of the war. These two alloys - one nickel-base and the other cobalt-base - were used, with only slight modification, in equipment actually used during the war. The development of these alloys, one wrought and one cast and their successful fabrication by forging and by precision casting.

Data on
?

THEORY?

United States 1946

ALLOYS FOR HIGH TEMPERATURE SERVICE, PART L, W. O. Binder, Iron Age, v. 158, Nov. p. 46-52.

Qualifications of metals and methods of evaluating alloys for high-temperature service, comparing prewar alloys with those more recently developed. A study is also made of the effects of various alloying elements in enhancing high-temperature properties.

Datum
?

United States 1946 THEORY

ALLOYS FOR HIGH TEMPERATURE SERVICE, PART II, W. O. Binder, Iron Age, v. 158, Nov. 14, p. 92-95.

Effects of strain hardening, heat treatment, and grain size control, in enhancing desirable qualities of the various tupes of alloys for high-temperature service are reviewed, supported by quantitative test data. Also stresses the importance of characteristics such as fatigue endurance, damping capacity and weldability in determining the suitability of the alloys for use at elevated temperatures.

United States 1946

COBALT BASE HIGH TEMPERATURE ALLOYS, L. E. Browne (Steel, 118 (21) 88-91,132.

Compositions of cobalt-base alloys are given together with tables of thermal-expansion coefficient, age-hardening data, endurance properties, short-time tensile properties, creep-test data, and average stress-rupture data. Casting methods and application are briefly outlined.

Data on
Cr-Steels

United States 1946

REQUIREMENTS OF STEELS FOR HIGH TEMPERATURE SERVICE, Claude L. Clark, Metal Progress, v. 50, Nov. p. 897-903.

Describes the present situation regarding a series of chromium steels containing from 5 to 9% chromium. Evaluation of high-temperature strength on basis of either rupture or creep strength; if application is one in which temperature rises continuously during operation, rupture strength is most suitable basis; if temperature is constant then creep characteristics serve best.

Data on alloys + ceramics

United States 1946

ALLOYS AND CERAMIC MATERIALS FOR HIGH TEMPERATURE SERVICE, H. C. Cross, Symposium on Materials for Gas Turbines (Amer. Soc. Testing Mat.) p. 113-120.

A progress report and an outline of the program for future work for the Office of Research and Inventions, U. S. Navy Dept. at Battelle Memorial Institute. Engineering properties of heat-resisting alloys; chromium-base alloy; fundamental factors promoting high-temperature strength of alloys; causes of cracking in welds and adjacent parent metal; weldability of heat-resisting alloys; and fundamental studies of ceramic materials.

Data on
Co - Cr
+
Co-Cr-Ni
alloys

United States 1946

HEAT RESISTING METALS FOR GAS-TRUBINE PARTS, Howard C. Cross and Ward F. Simmons, Symposium on Materials for Gas Turbines (American Society for Testing Materials) p. 3-51, discussion p, 121-128.

Results of high-temperature tests on various heat resisting alloys. The materials studied ranged from odified 18%-Cr, 8%-Ni steels to practically iron-free Co-Cr and Co-Cr-Ni alloys with additions singly or in combin tion of Mo, W, Cb, Ta, Ti, Al, B, and N_2. Short-time tension tests were made on the precision-cast, Co-base alloys at 1000 to 1600°F. Stress-rupture tests were made at 1500, 1600, and 2000°F for times varying from 1oo to 1000 hr. Creep tests were made at 1350, 1500, and 1600°F to determine the stresses required to produce creep rates of 0.00001% per hr.

Data on 18-8

United States 1946

FUNCTIONS OF ALLOYING ELEMENTS IN HEAT RESISTING STEELS, Herbert Dobkin, Steel, v. 119, oct. 28, p. 78-79, 106, 108,111.

Explains some the fundamentals of the metallurgy of heat resisting alloys; discussion based on wrought 18-8 chromium-nickel stainless steel. Functions of the alloy content of 18-8 and the effect of the modification of this analysis by further alloy additions. Such modifications are the basis for the development of most of the wartime superalloys.

Data on Al-alloy sheets

United States 1946

TENSILE PROPERTIES AFFECTING THE FORMABILITY OF ALUMINUM ALLOY SHEET AT ELEVATED TEMPERATURES, A. E. Flanigan, L. F. Tedsen, and J. E. Dorn, Jour. Aeronaut. Sciences, V. 13, Sept. pp. 457-468.

Fifteen aluminum-alloy sheet materials were tested at elevated temperatures in order to determine the influence of their tensile properties on their formability. Load-extension data were obtained for each condition; the effects of temperature, strain rate, and exposure time were studied. It was concluded that:

1) The appreciable increase in the elongation at high temperatures suggests that forming operations may be facilitated at such temperatures.

2) A general decrease in the limit of uniform elongation takes place at high-temperatures.

3) A fifty-fold change in the strain rate has an appreciable effect at elevated temperatures, even though an increase in temperature is equivalent to a decrease in strain rate.

4) For temperatures up to at least 450°F, the time at temperature is relatively unimportant for times ranging between 5 and 20 minutes, in the case of materials subject to precipitation hardening.

United States 1946

STRESS RUPTURE AND CREEP TESTS ON ALUMINUM ALLOY SHEET AT ELEVATED TEMPERATURES, A. E. Flanigan, L. F. Tedsen and J. E. Dorn; Metals Technology, V. 13, No. 6, Sept. 32 pp. also AIME TP No. 2033.

Stress-rupture and creep tests were run on five high strength aluminum alloy sheet materials at tempertures from 94°F to 375°F. Fracture times ranged from several minutes to 1000 hours. Data were obtained on fracture times, elongation at fracture, creep rate and creep intercept; complete strain versus time curves were obtained.

On the basis of rupture stress alone 75S-T ranks first for temperatures below 211°F, while for temperatures above 211°F, 24S-T86, 24S-T81, and 24S-T rank higher. At temperatures above 150°F, rupture stresses are generally lower than yield stress values of comparable short-time tensile tests. Similarly the elongation at fracture in stress rupture tests is less than that obtained in short-time tensile tests. Therefore, caution should be exercised in the use of tensile properties at the higher temperaturs.

The stress rupture fractures are either perpendicular to the specimen axis, or inclined at an angle of 60°. The former is true for all specimens (except 75S-T) at high temperatures, the latter for all specimens (except 75S-T) at low temperatures. For 75S-T the reverse is true.

Data on Al-clad XB 75S-O

Equip

United States 1946

AN AUTOGRAPHIC METHOD FOR OBTAINING LOAD EXTENSION RECORDS OF HIGH SPEED TENSILE TESTS ON SHEET SPECIMENS AT ELEVATED TEMPERATURES, Alan. E. Flanigan. L. F. Tedsen J. E. Dorn, and H. R. Kaiser; Jour. Aero Science, V. 13, Aug. pp. 405-410.

An apparatus has been developed for obtaining load extension records of tensile tests on sheet specimens at elevated temperatures. It has been used successfully at temperatures up to 900°F and at strain rates as high as 1 per sec. Difficulties are encountered, however, in determining the load at fracture. Typical results are shown to illustrate the effects of testing temperatures and strain rate on the load extension curves for XB75S-O Al-clad sheet.

United States 1946 Equip Dutch Com. Al-alloys

COMPRESSIVE PROPERTIES OF ALUMINUM ALLOY SHEET AT ELEVATED TEMPERATURES, A. Flanigan, L. Tedsen and J. E. Dorn, Proc. ASTM. V. 46, pp. 951-969. Also Symposium on Materials for Gas Turbines, ASTM, pp. 161-179.

This report includes a detailed description of the special testing apparatus used for compression tests on aluminum sheets at temperatures up to 300°F, as well as the results obtained from these tests. Specimens of 24S-t, 24S-T81, 24S-T86, R301-T and 75S-T were tested after being exposed to the elevated testing temperatures for periods ranging from 1/2 to 1000 hours; the 0.2% offset compressive yield strength, the modulus of elasticity in compression, and the tangent modulus were determined for each specimen. From comparisions of the effects of time and temperature on the tensile and compressive yield strengths, the authors found that the compressive yield strengths are closely related to and can be calculated from the tensile yield strengths.

Data on "High temp" Alloys

United States 1946

HIGH-TEMPERATURE ALLOYS DEVELOPED FOR AIRCRAFT TURBO-SUPERCHARGERS AND GAS TURBINES, J. W. Freeman, E. E. Reynolds and A. E. White, Symposium on Materials for Gas Turbines (Amer. Soc. for Testing Materials) p. 52-79.

Alloys developed during work for the NACA at the University of Michigan.

Data on Pb + Pb-alloys

United States 1946

CREEP TESTS ON SOME EXTRUDED LEAD AND LEAD-ALLOY SLEEVES AND TAPES, G. R. Gohn, S. M. Arnold, and G. M. Bouton, Amer. Soc. for Testing Materials, Proceedin s. v. 46, p. 990-1020.

Creep test cover a period of approximately 8 yr. on specimens from 16 commercial lead cable sleeves of 6 different compositions and from 14 experimental Pb-alloy tapes. The data show tha chemical lead sleeves are more resistant to creep than Pb-Sn or Pb-Sb sleeves at low stresses but not at high stresses. For the tape specimens, a similar relationship was found except that high Ca alloys are superior to chemical lead in creep resistance at all stresses. High-purity, fire-refined lead, which contains smaller percentages of minor constituents than chemical lead, was inferior to chemical lead at all stresses. 13 ref.

Data on Ni-Cr-Co-Fe & Co-Cr-Mo alloys

United States 1946

HIGH TEMPERATURE ALLOYS, N. J. Grant; Iron Age, V. 157, May 23, 1946, pp. 42-45, 48 - May 30, 1946, pp. 50-56 - June 30, 1946, pp. 60-63.

The purpose of this research is the development of superior alloys for performance in gas turbines at about 1500°F and the study of the effect of nitrogen, carbon, tantalum and columbium on certain nickel-chromium-cobalt-iron base complex alloys. Additional tests were made at 1600°F. Studies of the surface polishing of specimens, of the temperature of investment molds, and finally of the high carbon vitallium type alloys are also included. 37 alloys were tested in the forged and heat treated condition. Their composition as well as the result of rupture and creep tests at 1500° are tabulated. The composition of 80 Ni-Cr-Co-Fe base cast alloys and of 37 vitallium base cast alloys as well as the result of rupture and creep tests at 1500° and 1600°F at various stresses are also tabulated. Many alloys were found to be nonforgeable. Extensive metallographic and x-ray examination of all the alloys was made for various treatments. Mold preheat temperature was investigated to determine the optimum preheat temperature for the best all-around alloy performance. High temperature failure and strength and ductility comparisons among the alloys are also presented.

Data on
High temp alloys

United States 1946

SUPERALLOYS FOR HIGH TEMPERATURE SERVICE, Harold A. Knight, Materials & Methods, v. 23, June, p. 1557-1563.

Heat resistant materials developed for gas turbines and related uses. Included is a table of high-temperature alloys.

United States 1946

PROPERTIES OF CERIUM-CONTAINING MAGNESIUM ALLOYS AT ROOM AND ELEVATED TEMPERATURES, T. E. Leontis and J. P. Murphy, Metals Technol. 13 (3) and AIMME Tech. Publ. No. 1995 32 pp.

The properties of magnesium-cerium alloys containing up to 10% cerium were examined at temperatures up to 700°F (371°C); the cerium was added in the form of "misch metal" and thus contained a large percentage of lanthanum and other rare earths which were included in the term cerium content. In general, the magnesium-cerium alloys retain much of their strength at elevated temperatures (400°F) and exhibit high resistance to creep over a wide range of temperatures. These properties are somewaht improved by additions of manganese and if the manganese content exceeds 1.1% the corrosion-resistance (in 3% aqueous sodium chloride) is greatly increased. Additions of aluminum tend to decrease the strength at high temperatures, but increase the ductility and electrical conductivity. Microstructures are reproduced and details given of creep tests, tensile tests, hardness tests, and measurements of the electrical and thermal conductivities.

United States 1946 Theory

Nickel + Cu

INFLUENCE OF STRAIN RATE AND TEMPERATURE ON THE MECHANICAL PROPERTIES OF MONEL METAL AND COPPER, D. J. McAdam, G. W. Geil, D. H. Woodard, Proc. ASTM V. 46 p 902.

This paper discusses the relation between creep rate, temperature, flow stress, breaking stress, and ductility, and then presents a general view of the influence of the strain and temperature, to the mechanical properties of monel metal and oxygen-free copper between -188°C and the melting points.

The third stages of creep may be initiated by the formation of microcracks, predominantly intercrystalline. Evidence indicated that the lowered ductility resulted from the combined effects of the higher temperatures and the slower strain rates in the creep tests.

Cracking occurs when the rising true stress reaches a technical cohesion limit determined by the temperature, strain rate, and amount of plastic deformation. Progressive disintegration thus begins and continues to complete fracture. Photomicrographs show that the cracks are fewer but generally larger in the copper than in the monel metal. The number of cracks tends to increase with increase in the temperature and with decrease in the strain rate. Local contraction appears when test is carried at the highest strain rate, but disappeared with decrease in the strain rate. The tendency to local contraction was greater with the copper than with monel metal. In specimens that contract locally before fracture, the number of cracks tends to increase in the notched portion with approach to the surface of complete rupture.

Both the second-stage flow stress and the cohesion limit increase with decrease in temperature and with increase in the strain rate. Decrease in temperature or increase in strain rate increases the cohesion limit to a greater extent than the flow stress; the ductility thus increases. The accelerated increase in the ductility with increase in the strain rate may not continue up to a high rate of strain. The ductility for complete fracture of both monel metal and copper also increases at an increasing rate with increase in the initial breaking stress.

United States 1946

TENSILE AND CREEP STRENGTHS OF SOME MAGNESIUM-BASE ALLOYS AT ELEVATED TEMPERATURE, A. A. Moore, and J. C. McDonald; Proc. A.S.T.M., V. 46, pp. 970-989. Also in Symposium on Materials for Gas Turbines, A.S.T.M., pp. 180-199.

The results of creep tests at temperatures up to 300°F and up to 1000 hours duration on 1.) several commercial magnesium-base alloys (all of which were relatively stable within the range of test temperatures) and on 2) certain experimental cerium-containing alloys are offered as a basis for qualitative and comparative use in design. The report data include alloy designations, nominal compositions, typical room temperature properties, tensile properties at elevated temperatures, and creep properties at elevated temperatures. The authors found no loss of ductility at rupture after 1000 hours for the alloys tested. By comparing yield and tensile strength with creep properties (as listed in Table VI of the report) a suitable stress for high temperature service can be obtained.

Data on
27% Cr-Iron

United States 1946

PROPERTIES AND CHARACTERISTICS OF 27% CHROMIUM IRON, H. D. Newell, Metal Progress, v. 49, May, p. 977-991, 993-1006, 1016, 1018, 1020, 1024, 1028.

Studies originally intended for manufacturers of raw material for synthetic rubber. Description of the alloy; properties at elevated temperatures; short-time tensile properties; creep strength of stainless steel, type 446; impact properties and notch sensitivity; effect of depth of notch on impact strength; structural characteristics; embrittlement phenomena; working and fabricating; effect of time and temperature in removing 885°F embrittlement in 25% chromium irons; heat treat (annealing); service examinations and data; oxidation rate (in. per 1000 hr.) of various alloys after plant exposure in butadiene reactors; chemical composition versus hardness and amount of sigma constituent in 27% chromium-iron tubes after plant service.

United States 1946

Data on Cr base alloys

CHROMIUM-BASE ALLOYS, Robert M. Parke and Frederick P. Bens, Symposium on Materials for Gas Turbines (Amer. Soci. for Testing Materials) p. 80-98. Dis. p. 121-228.

Results of an investigation of Cr-base alloys sponsored by the War Metallurgy Committee of the N.D.R.C. at Climax Molybdenum Co. Heat resistant metals being sought were for use as gas-turbine blades rotating in an oxidizing atmosphere at temperatures up to 1600°F. The alloys were also applied experimentally as erosion resistant materials for ordnance uses.

United States 1946

ALLOYS BEAT THE HEAT, Fred P. Peters, Scientific American, v. 174, April p. 152-154.

Brand new alloys, and some old standbys from other fields, are key materials of turbosuperchargers, gas turbines, and jet engines. Their compositions and methods by which they were formed are now revealed.

United States 1946

INTERNAL FRICTION AND PLASTIC EXTENSION OF ZINC SINGLE CRYSTALS, Thomas A. Read and E. P. T. Tyndall; Jour. Applied Physics. V. 17, No. 9, pp. 713-720.

Data are given on the internal friction of four single crystals of zinc made to oscillate longitudinally. A description of various slow speed tension tests within and beyond the elastic limit is included; the results of such tests are given. The single crystals are made of "Bunker Hill" zinc containing about 0.01% impurities. The results are compared with those obtained with still purer crystals prepared by another method. The decrement is higher at the lowest stress amplitudes, but in comparison to that of the purer metal, it increases very slowly with increasing stress-amplitude.

United States 1946

PRECISION CAST PARTS OF HIGH TEMPERATURE ALLOYS, W. O. Sweeny. Product Engineering V. 17, pp. 121-126.

Physical and mechanical properties, creep data and chemical composition of five Haynes-Stellite alloys. Design data are given dealing with tolerances on dimensions, weight and dimensional limitations on sizes of precision-cast parts and types of parts generally suited for manufacture by precision casting methods.

United States 1946

THE EFFECT OF CARBIDE SPHEROIDIZATION UPON THE RUPTURE STRENGTH AND ELONGATION OF CARBON-MOLYBDENUM STEEL, S. H. Weaver; Proc. A.S.T.M., V. 46, pp. 856-869.

High temperature service will cause spheroidization of the carbide particles in steel, thus changing the properties of the material. Specimens of carbon-molybdenum steel plate were treated so as to obtain 12 different structures of the steel, representing "conditions" which might result from high temperature service. The results of long-time rupture-stress and elongation tests on the various structure are reported and interpreted for runs at 900°F and 1000°F.

United States 1946

HIGH-STRENGTH HIGH-TEMPERATURE ALLOY S-816, Thomas Y. Wilson, Materials & Methods, V. 24, Oct. pp. 885-890.

High strength at 1500°F resistance to burned fuel gases, and ease of fabrication are among the favorable characteristics of this cobalt-base alloy (44%) containing 20% chromium, 20% nickel, 4% molybdenum, 4% tungsten, 4% columbium, 1.5% max. manganese, 1.0% max. silicon, 0.40% carbon and4% max. iron.

Data on Cr-Ni-Fe, Co-Cr, Cr-Ni-Co + Ni-Co-Fe alloys

United States 1946

NEW HEAT RESISTING METALS FOR ENGINES, R. K. Winkleblack, Automotive and Aviation Industries, v. 95, Oct. 15, p. 40-44.

What design and development engineers can expect of alloys for high-temperature applications in internal combustion engines. Alloys are principally of chromium-nickel-iron, cobalt-chromium, chromium-nickel-cobalt, and chromium-~~mxixk~~ nickel-cobalt-iorn bases. Results of tests are summarized. Lists laboratories and companies in which materials were made and tests carried out.

United States 1946

HASTELLOY ALLOYS, WROUGHT AND CAST, Machine Design, V. 18, Nov. p. 155-158.

Properties; physical constants; characteristics; applications; fabrication; resistance to corrosion; annealing.

Data on German Steels

United States 1946

HIGH TEMPERATURE STEELS, Iron and Steel, v. 19, April, p. 159-160.

Some wartime results of German jet engine researches. Compositions and properties of five steels used for gas turbine blading.

United States 1946

Data on German steels

HEAT RESISTING STEELS, Iron and Steel, v. 19, July p. 433-435.

Performances and physical properties of the German Krupp steels Tinidur and Cromadur are detailed, and are shown in tables. Analyses of other steels developed in order to overcome the scarcity of certain elements are given, together with purposes for which they were designed. Some of their physical properties are shown.

Data on Haynes Stellite alloys

United States 1946

SECRET WARTIME HIGH TEMPERATURE ALLOYS NOW AVAILABLE FOR PEACETIME USE, Machinery, v. 52, July, p. 183-187.

Several Haynes Stellite alloys have been developed during the war that are finding peacetime applications in fields calling for high temperature creep and rupture strengths.

Data on steels

United States 1946

PROPERTIES OF STEELS FOR HIGH TEMPERATURE SERVICE, Materials and Methods, v. 23, Mar. p. 769, 771.

Table I lists composition and room temperature physical properties of steels used in high temperature service; Table II gives variation in physical properties with temperature for steels listed in Table I.

United States, 1946

Data on Steels

CREEP STRENGTH OF STEELS, Oil and Gas Journal, v. 45, Nov. 9, p. 103.

Chart shows creep of 16 alloy steels in approximate range 900 to 1400°F.

United States 1946

Cr-Ni-Co
S-590, S-810, S-588

HEAT AND CORROSION RESISTANT HIGH TEMPERATURE ALLOYS; Product Engineering, V. 17, September, pp. 151, 153, 155, 157.

The tensile and creep properties of three alloys were studied both at room temperature and at 1200°F - 1500°F.

The chrome-nickel-cobalt alloys S-590 and S-810 were found to possess good high temperature properties and a high oxidation resistance.

S-810 has the better properties and is used in turbine buckets, while S-590 is used in turbine wheels. The third alloy examined, S-588 (chrome-nickel alloy) has good high temperature properties, but is poor in its resistance to oxidation.

United States 1946 E QUIR

TENSION TESTING AT ELEVATED TEMPERATURES, T. M. Blackman, P. R. Mourse, and E. H. Plesset, ASTM Bulletin No. 140, May pp 32-37.

Simple and inexpensive method of heating tension specimens by resistance, a method of measruing specimen temperatures, and two types of extensometers and the associated electronic equipment for use with a Baldwin-Southwark recorder. One extensometer is a reworked compressometer for use in the elastic range. Other measures elongations up to 50% of a 2-in. gage length for studies in the plastic range. Tension specimen may be broken with out damaging the latter extensometer. Calibrating adjustments have been set so that 50% elongation results in a 10 in. record (of the elongation) on a Baldwin-Southwark tension machine recorder; the elastic range is necessarily so foreshortened that it is not discernible on the record. Also discusses technique for determining the true load at fracture of ductile specimens.

United States 1946

CREEP TESTING EQUIPMENT AT RUSTLESS IRON AND STEEL CORP., E. E. Denhard; Instruments, V. 19, January, p. 12.

Readings of the order of 1%/10,000 hours are accurately obtained, and creep rates of 0.1%/100,000 hours are reliable. Fluctuations at 1500°F are less than 1°F, and the temperature gradient in the furnace is maintained at less than 2°F.

EQUIP

United States 1946

A HIGH PRECISION ONE-INCH ELECTRICAL EXTENSOMETER, H. M. Mahan and Wm. B. Warren, Instruments, V. 19, Sept. pp. 502-505.

A gage is described which retains the simplicity and sensitivity of the bonded-wire strain gage and in addition is applicable to long-term studies. The features of this instrument suggest the possibility of mounting gage points on permanent structures such as bridges, roofs, and dams, with the idea of maintaining a constant check on these strutures. The instrument can measure with extreme precision the distance between gage points at any time during test periods of several months duration.

United States 1946 EQUIP

SCREW-DRIVEN CREEP-RUPTURE TESTING MACHINE, M. J. Manjoine; Metal Progress, V. 50, No. 5, pp. 1100-1101.

A creep curve is automatically drawn for each test specimen; there are no weights or extensometers on the machine, a motor driven screw jack being used in conjunction with a spring in series with it to measure the force, and the travel of the screw jack being a measure of the creep at constant load.

United States 1946

NEW MACHINES FOR CREEP AND CREEP RUPTURE TESTS, M. J. Manjoine; Machinery LLoyd, V. 18, No. 25, pp. 96-101.

High temperature creep and creep-rupture testing machines designed at the Westinghouse research laboratories.

England 1946

CREEP OF METALS (Report on Royal Society Conference Feb., 1946 - Andrade, Orowan, Tapsell, McCance and Allen), N.P.Allen; Nature, V. 157, No. 3989, pp. 469-471.

Report of a conference concerning the measurement, empirical expressions, and the influence of metallurgical structure in creep. Papers include theoretical works by Andrade, Becker, and Orowan. Tapsell discusses the various methods of creep testing employed at the national physical laboratory. Dr. McCance relates strain hardening to the increase in volume accompanying plastic deformation. N. P. Allen discusses the effect of grain-size on the creep properties; the addition of elements which raise the softening temperature, in conjunction with work-hardening, results in the improvement of the creep properties.

England 1946 Theory

CREEP OF METALS, A. McCance; Engineering, V. 161, pp. 258-259.

Dr. McCance states that metals subjected to plastic flow possess two important characteristics amongst others, the increase in volume, and the increase in hardness; these phenomena are correlatable. Internal stresses are produced by the volume changes which in turn depend upon the compressibility of the material. These internal stresses account for the change in hardness. The effect of volume change on the stress-deformation relations is studied for the case of slip along glide planes. By means of the above correlations, Dr. McCance extends his theory and applied it to creep and to fatigue. In the case of fatigue it is not clear why the fatigue strength of mild steel should be approximately one-half that of the tensile strength. The extension of the theory to creep and to fatigue is a mathematical one, and is based upon the stress deformation relations, which in turn are obtained from volume and hardness data in the manner described above.

England 1946 THEORY

STRESSES IN ROTATING DISKS AT HIGH TEMPERATURES, A. S. Thompson; Jour. Applied Mechanics, V. 13, No. 1, p. A-45.

A general method was found by which the problem of the rotating disk with any arbitrary profile could be solved, including the effect of plastic flow and of variable temperature, and including the change with temperature of modulus of elasticity, coefficient of thermal exapnsion, and allowable stress. The solution requires for its application to a specific disk only the elementary arithmetic involved in completion of a tabular form sheet. Two applications of the method are made. For an arbitrary disk profile, an integral equation was found which converges rapidly to the radial stress distribution in a series of successive substitutions. For an arbitrary choice of radial stress, the necessary disk profile can be found in one calculation. Appendix 1 gives an example of the use of the method for the design of a partially plastic disk with a central hole.

England 1946 T[illegible]

CREEP OF METALS, National Physical Laboratory Conference, Engineering 161, pp 233-5, 258-9.

Different aspect of the subject were dealt with in turn by Andrade, Tapsell, Orowan, Allen etc.

1. Tapsell, H. J. - For a given temperature, the rate of creep under stress is an extremely sensitive indicator of the mechanical strength of a metal.

From tests on lead, a magnesium alloy, and some steels, it has been ascertained that, for each material and for a restricted range of stress and time, the creep curves at each stress have the same geometrical form. Also, the creep curves for a material under tension, torsion and a combination of tension and torsion, have the same geometrical form.

2. McCance, A - Metals subject to plastic flow passed two characteristics - they increased in hardness and they increased in volume. They are correlated phenomena and that the internal stress, produced by the volume changes which will be connected with the compressibility of the material, accounts for the changes in hardness. The speaker had studied these volume changes and their effect on the stress-deformation relations when slip took place along the glide planes.

England 1946

Data on Co-base alloys

COBALT-BASE HIGH TEMPERATURE ALLOYS, L. E. Browne; Steel, V. 118, No. 21, pp. 88-91, 132.

Age hardening data, endurance properties, short-time tensile properties, and creep and stress rupture data for various high-temperature cobalt base alloys are tabulated.

England 1946

MAGNESIUM-CERIUM-ZIRCONIUM ALLOYS: PROPERTIES AT ELEVATED TEMPERATURES, A. J. Murphy and R. M. Payne; Jour. Institute of Metals, V. 73, November, pp. 105-127.

Magnesium-cerium alloys are successfully cast in sand molds. The mechanical properties are poor at room temperature, but the creep resistance and strength at 200°C are good. The addition of zirconium refines the structure and leads to a considerable improvement of the proof stress, ultimate stress, and ductility.

The best properties were obtained with an alloy containing about 3% cerium and 0.6% zirconium, the mechanical properties of this alloy being of the same order of magnitude as those found in magnesium-aluminum alloys. In addition, these alloys cast well and give sound products.

England 1946

Oliver, D. A. and Harris, G. T.; Metallurgia, 34, p. 293.

Steel.

Data on Al-Si alloys

England 1946

PROPERTIES OF THE ALUMINUM-SILICON ALLOYS AT TEMPERATURES IN THE REGION OF THE SOLIDUS, A. R. Singer and S. A. Cottrell; Jour. Ins. of Metals. V. 73, pp. 33-54.

The tensile properties of aluminum-silicon alloys (0-12% Si) were determined at temperatures in the solidus region in order to determine the mechanism of hot-shortness. The ductility rapidly drops to zero at the solidus, but some strength remains up to a point about half way between the solidus and liquidus. The extent of this region (above the solidus) appears to be an important factor in regard to the hot-shortness characteristics of the alloys. Up to the solidus, the decrease in tensile strength with increasing temperature is greater for the alloys with larger silicon contents, but the ductility remains high in all the alloys up to a point just below the solidus. The temperature range above the solidus, within which the alloys retain some small degree of strength, is maximum at approximately 1.8% silicon.

ENGLAND
~~France~~ 1946

THE MECHANICAL PROPERTIES, INCLUDING CREEP, OF ALUMINUM BRONZES AT ELEVATED TEMPERATURES, E. Voce, Metallurgia, V. 35, No. 205, pp. 3-9.

Tensile tests were carried out at room temperature, 250°C and 400°C; creep tests at 250°C and at 400°C; and notched bar impact tests at room temperature, 200°C, and at intervals of 50°C up to 600°C.

The creep properties of aluminum-bronze were compared to those of tin-bronze, gun metal, and Cu-Si-Mn alloys. Because of its resistance to oxidation, aluminum-bronze appears to be the most promising copper base alloy for service at moderately elevated temperatures. In regard to creep resistance, aluminum bronze is inferior to the silicon alloy, but is superior to the tin-bearing alloy. Tensile test reveal that the presence of the gamma phase does not diminish the ductility to as great an extent as is popularly supposed. From a comparison of no ched-bar test results, it is evident that stabilization of the extruded alloy causes a considerable degree of embrittlement at temperatures of up to 450°C. At 600°C, the alloy becomes tough, due to the presence of the beta phase.

Data on alloy steels

England 1946

CREEP RESISTANT ALLOY STEELS, S. E. Wolfson and M. P. Myahkov; Metallurgia, V. 33, April, pp. 287-290.

The selection of steels for high temperature service provides many engineers with problems of a complex character. It is well known that steel maintains comparative permanence of properties and dimensions at atmospheric and moderate temperatures, but where high temperatures are concerned and the metal is subjected to intermittent heating and cooling, as in high tempemature steam plant, the phenomenon of creep must be considered. The subject has been given considerable study. A more recent investigation on the behavior of alloy steels at prolonged high temperatures has been carried out and reported upon in Russia, the main results of which are given in this article. The investigation shows that the addition of molybdenum to steel imparts high heat strength. Vanadium has a similar effect on alloy steels but to a lesser degree.

England 1946 Theory Dunn Al

MECHANISM OF CREEP IN METALS (ALUMINUM), W. A. Wood and H. J. Tapsell; Nature, V. 158, No. 4012, pp. 415-416.

The grains of a polycrystalline metal under tension break down into crystallites characterized by widely differing orientations and by a particular lower limiting size which is a constant of the material. This has been termed "random crystallite formation". Under similar loading of single crystals, a dislocation of the mosaic structure occurs, but the mosiac elements in general remain parallel. The condition has been termed the "parallel crystallite formation". Experimental results show that a polycrystallite specimen in creep will deform like a single crystal in tension.

A specimen of aluminum, previously annealed, was stretched at 300°C in a normal tensile test to an extension of 0.9%; the extension was completed in two minutes. The specimen was then unloaded, cooled and examined by x-rays. A similar specimen was allowed to creep under a load of 1/2 ton/sq.in. at the same temperature until the same extension was reached, but the extension took 50 minutes. X-ray examination showed that the tensile specimen had a random crystallite formation, while the creep specimen had a parallel crystallite formation.

When the tensile specimen, after unloading, was held at the elevated temperature for the same time as the creep specimen, no appreciable recovery occurred in the structure.

England 1946 Equip

A SMALL-SCALE CREEP-TESTING UNIT, G. T. Harris, Metallurgia, V. 34, July, pp. 129-139.

Much research work has been carried out to devise suitable apparatus and technique with the object of determining the strength of an alloy at elevated temperatures, particularly resistance to creep deformation. Further work has been carried out on short-time tests in order to accelerate the development of a small-scale creep-testing machine. This machine is described and some results are given showing the form of the strain-time curves obtained.

France 1946 Theory Data on Mg, Al + Zn

THE ROLE OF INTERGRANULAR BOUNDARIES AND THE DEFORMATION OF METALS. APPLICATION TO CREEP AND FATIGUE, Charles Crussard; Revue de Metallurgie, V. 43, No. 11/12, Nov.-Dec. pp. 307-316.

An investigation of the influence of grain boundaries on the fatigue and creep properties of magnesiu, aluminum, and zinc. It is concluded that there is no amorphous film in the grain boundary in annealed metals. It is believed that at small stresses internal friction is caused by a micro-flow, and that ordinary flow has both transcrystalline and intergranular origins. The conclusions are based on a classification of different types of creep based on the heats of activation.

France 1946

CONTRIBUTION TO THE KNOWLEDGE OF THE ALLOY AL-ZN-MG-CU-CR, Mladen Paic, Compt. rend. 223, pp. 727-729.

The alloy examined had the composition: zinc 8.5, magnesium 2.3, copper 1.5, chromium 0.25, iron 0.07, and silicon 0.03% balance aluminum, and was in the form of 14 mm. bars and 50 mm. thick paltes. The variation of the tensile strength with the temperature was plotted, and showed that the strength of the plates is distinctly less than that of the bars above 290°C because they begin to recrystallize at 300°C and are completely recrystallized at 320°C. The corresponding temperature for the bars are 380° and 420° and 500°C. The mechanism of agehardening was investigated by radiocrystallography on two sets of specimens differently heat-treated and the results are discussed.

France 1946

Tapsell, H. J.; De. Inqenieur 30, p. 57.

Measured creep rate after 5 days under stress of 8 ton/sq.in. at 450°C of 47 samples of rolled steels. Steels varied in C content from 0.14 to about 0.4%; no correlation of creep performance with C content. Got variation in creep rate of 500:1.

France 1946

EQUIP.

A MICRO-MACHINE FOR THE MECHANICAL TESTING OF METAL WIRES AND TEXTILES, Pierre Chevenard; Techn. Moderne, V. 38, No. 21/22, pp. 249-254.

A miniature machine for tension testing wires at room and at high temperatures, dry or immersed in a liquid. A screw mechanism extends the wire, while at the other end of the wire and in series with it, is a steel strip whose deflection is proportional to the applied force; this deflection, and the screw motion are transmitted to a mirror sotthat the two motions appear at right angles to each other. It follows that the light spot reflected by the mirror traces out a force-extension diagram.

Sweden 1946

BRITTLE FRACTURE OF STEEL UNDER SUSTAINED LOAD AT ELEVATED TEMPERATURE, C. Schaub, Eng. Digest, V 3, July pp. 333-334.

To obtain general information with regard to the tendency to embrittlement of 16 steels, specimens were subjected to a 1000-hr test at 500°C. Impact tests were carried out both before and after the 1000-hr test. Conclusion is that the ordinary limiting creep stress test should be complemented by a corresponding test on notched test bars. In the latter test a stable material should not exhibit any tendency to embrittlement or to fissure formation in the notch similar to stress-corrosion.

India 1946

GAS TURBINES AND JET PROPULSION, R. P. Probert; Indian Eng. - British Council Publication, V. 120, No. 5, pp. 267-270.

Data on materials possessing good creep properties at high temperatures (including information on the Nimonic 80 alloy) are discussed in relation to the production and design of high temperature machinery.

Data on 18-8 with Cb, Ti, Ta, Mo + W

Germany 1946

EFFECT OF COLD WORKING ON CREEP STRENGTH, H. Zschokke; Schweizer Archiv. V. 12, October, pp. 297-304.

The high temperature creep strength of three 18-8 stainless steels containing Cb, Ti, Ta, Mo and W is investigated in relation to the prior cold work and to the rolling temperature.

Russian 1946 Theory

ON THE QUESTION OF THE ABNORMALLY HIGH PLASTICITY OF CERTAIN ZINC-ALUMINUM ALLOYS, A. A. Bochvar and Z. A. Sviderskaya (Izvest. Akad, Nauk SSSR pp. 1001-1004 (in Russian).

Ainc-aluminum alloys containing 75-85% zinc, on heating to 100°-300°C after preliminary quenching, become many times softer and more plastic than the pure component metals and the alloys containing 0-75 and 85-100% zinc, heated to similar temperature. The unusual increase in plasticity is observed with a granular structure but now with a lamellar one. The following explanation of the pehnomenon is given. Plasticity depends on the mechanism of deformation, on the initial capacity for deformation, and on the possibility of this capacity being restored during the deformation process by the removal of work-hardening and the "healing" of sub-microscopic sources of failure which arise in deformation. If these is a sufficiently large mutual solubility of the component elements of the alloy and one which changes rapidly with temperature, mutual solution takes place on account of the local increase in temperature and the reverse process of separation occurs on cooling. In this way, as a result of the transference of atoms through the solution, "healing" of the sites of incipient failure can take place.

THEORY

United States 1946
(RUSSIA)

THE THEORY OF PLASTICITY—AN OUTLINE OF WORK DONE IN RUSSIA, W. W. Sokolovsky, J. Appl. Mechanics, 13 (1) A1-A10.

Mathematical. Russian work in developing the Mises-Hencky theory of plasticity is reviewed with special reference to the elastic-plastic bending of plates and shells, the plastic state of plane strain, and plastic states of plane stress. A bibilography of 24 references is given.

Russia 1946 Theory

THE INFLUENCE OF RATE ON THE RESISTANCE OF METALS TO PLASTIC DEFORMATION, L. D. Sokolov (Zhur. Tekhn, Fiziki, 16, pp. 437-422 (In Russian).

Static compression tests (at rates of 0.01 and 1.0 mm. sec.) and dynamic tests (at an average rate of 2000 mm/sec.) were carried out in the cold and at elevated temperatures on 20 mm. high cylinders of lead, copper, and steels of various carbon contents. True-stress curves were constructed from the results. The rate coefficient (i.e., the ratio of the change in true stress to change in rate) increases with rise in temperature and with diminution of the mp of the metal, and has a single-order value for an increase in rate in the ranges indicated above.

Theory ? Data on ?

Russia 1946

THE PLASTIC DEFORMATION AND FAILURE OF POLYCRYSTALLINE METALS UNDER TENSION-I Apparatus, V.S.Averkiev, G. N. Kolesnikov, V. A. Pavlov and M. V. Yakutovich; Zhur Tekhn Fiziki (in Russian) V. 16, No. 11, pp. 1349-1356.

The range of testing temperatures lies between -195°C and 850°C, while the strain rate range lies between 2×10^{-5} cm/sec and 6.4×10^{-1} cm/sec.

Russia 1946

THE EFFECT OF THE RATE OF DEFORMATION ON THE PLASTICITY OF COPPER ALLOYS AT HIGH TEMPERATURES, A. V. Bobylev and A. I. Chipizhenko, Tsvet. Metally, pp. 7095, (in Russian)

Static (1-300 mm/min.) and dynamic (5 m/sec.) tests were carried out on wires of 6-7 mm. dia. of the following annealed (1 hr. at 600°C) alloys: brasses with 63.38% copper, 6212% copper and 57.55% copper ° 1.17% lead, and bronze containing 93.34% Copper, 3.53% tin, remainder zinc. At high temperature (500°, 750°, 800° and 850°C) the plasticity of the alloys (as indicated by the contraction in crosssection) increases with the rate of deformation. The results are given in tables.

Russia 1946

ELASTIC AFTER EFFECT IN PHOSPHOR BRONZE AT 110°C, N. N. Davidenkov and G. A. Kuzmirskaya, Zhur. Tekhn. Fiziki, 16, pp. 1261-1270 (in Russian).

An investigation was carried out on the elastic after-effect in specimens of phosphor-bronze strip (0.5 mm. thick) in the form of beams of equal strength. With various loads on the end of the strips, the change in the angle of bending of the end of each strip was measured at 110°C over a period of 1½ hr. It was found that the elastic after-effect increased at an ever-diminshing rate during that time and that in a further half hour it reached no higher value. With increase in stress the magnitude of the absolute elastic after-effect grows, while the relative value diminishes. With increase in the degree of rolling (cold working) the elastic after-effect increases both absolutely and relatively. Annealing sharply reduces the elastic after-effect; thus an hour's annealing at 160°C of a specimen reduced 50% in thickness by rolling, while causing practically no change in hardness, reduced the elastic after-effect seven times. For practical purposes a low temperature anneal is recommended.

Russia 1946

THE MECHANICAL PROPERTIES OF MAGNESIUM-RICH MAGNESIUM-ALUMINUM-SILVER ALLOYS, V. G. Kuznetsov and M. A. Skryabin, Izvest. Akad. Nauk SSSR Khim. pp. 557-568. (in Russian).

The Brinell hardness of magnesium-rich alloys whose compositions lay along three radial sections (silver: aluminum = 4:1, 1:1, and 1:4) was measured(a) after quenching from 300°C, Ib) after slow cooling, (c) after natural aging, (d) after artificial ageing, and isohardness curves were drawn. Plasticity increases with increase in the ratio of silver to aluminum, while the region of brittle alloys moves in the direction of high concentrations of alloying elements. The existence of a minimum on the hardness curves of the magnesium solid solution is established, and it is suggested that this corresponds to a state of short-range ordering. Investigation of the tensile strength and elongation of a series of cast alloys from the solid-solution range, at 250° and 300°C showed that the best mechanical properties are obtained with additions of 0.5-1.0% silver to alloys containing 3-5% aluminum. Among these investigated two stand out; (1) that containing silver 0.5, aluminum 4.24, manganese 0.40% has a tensile strength of 22.8 as quenched, 22.8 as slowly cooled, 13.6 at 250°C and 10.5 at 300°C with corresponding elongation values of 17.7, 12.1, 23.4 and 29.5%; (in kg./mm.^{2}) and (2) that containing silver 1.04, aluminum 3.09, manganes 0.27% has tensile strengths (in the same order as above) of 22.7, 23.3, 12.3 and 7.8 and elongation values of 18.3, 20.9, 41.3 and 52.8.

Russia 1946

NEW, HIGHLY HEAT RESISTANT MATERIAL "THERMITOMULLITE", R. I. Pevzner, Izvest. Akad. Nauk SSSR Tekhn (10) 1431-1437 (In Russian).

Thermitomullite, obtained by Goldschmidt's thermit process, is described.

Russian 1946

Fe

THE INFLUENCE OF SMALL IRON CONTENTS ON THE PROPERTIES OF COPPER AND ALPHA BRASSES, E. S. Shpichinetsky and I. L. Rogel'berg (Tsvot. Metally. pp. 54-60 (in Russian).

S. and R. studied the effect of small quantities of iron (0.005-0.5%) on the mechanical properties after deformation and annealing, the grain size, and the corrosion-resistance of copper and of brasses containing 5, 10, 15, 20 and 28% zinc. The effect of iron on the mechanical properties of the alloys "L80", "L68", and "L62" at elevated temperature was also examined. Iron in copper and copper-zinc alloys increases the hardness and strength, decreases the elongation, and inhibits grain growth. Iron markedly affects the plasticity of brasses at elevated temperatures. Up to 0.3% annealing at 600°650°C, alloys containing up to 0.15% iron have properties practically identical with those of iron-free alloys.

Russia 1946 THEORY

THE STATIC AND DYNAMIC COMPRESSION OF BRASSES HAVING VARIOUS ZINC CONTENTS, L. D. Sokolov, Zhur. Tekhn, Fiziki, 16, pp. 1277-1282 (In Russian).

Static compression tests at a rate of 1 mm/sec. and dynamic tests at a mean rate of 2000 mm/sec. were carried out on brasses containing 18, 25, 32, 38 and 52% zinc. True-stress curves were obtained which enabled a relation to be established between the rate (dynamic) coeff., the temperature of the experiment and the zinc content of the brass. The results of other workers are confirmed.

Russian 1946 Equip.

QUESTIONNAIRE RELATING TO MACHINES AND APPARATUS FOR MECHANICAL TESTING, F. P. Belyankin, N. N. Davidenkov, V. D. Kuznetsov, I. A. Oding and I. V. Kudryavtsev, S. V. Serensen, Ya. B. Fridman, E. M. Shevandin (Zavod, Lab. 12, pp. 328-362) (In Russian).

Reports the answers given by the persons indicated above to questions on the prospects for the development and invention of improved machines and apparatus for the mechanical testing of materials.

Russian 1946

NEW METHOD OF TESTING METAL SHEET, E. M. Shevandin (Zavod, Lab. 12 pp. 736-753) In russian.

To determine the mechanical properties of thin sheet, S. employed the method of statically pressing out a circular section from a round specimen. Tests were carried out on steel, aluminum, copper, brass and Duralumin. The method enables the true-stress diagram to be constructed and all the fundamental characteristics of the material to be determined.

United States 1947 THEORY

INTERCRYSTALLINE COHESION AND THE STRESS-RUPTURE TEST, H. H. Bleakney; Proc. A.S.T.M., V. 47, No. 34, pp. 575-595.

After presenting a background of prior work, the author discusses evidence related to the intercrystalline failure of metals, as well as the causes of such failure. Based upon this evidence, a hypothesis is advanced for the explanation of intercrystalline failures which emphasizes the role of oxidation.

United States 1947

INTERPRETATION OF CREEP AND STRESS-RUPTURE DATA, Francis Foley; Metal Progress, V. 51, No. 6, pp. 951-958.

A review including a discussion on the mechanism of flow and rupture in steels.

United States 1947 THEORY

THE FLOW OF METALS AT ELEVATED TEMPERATURES, PART I, II, J. H. Hollomon and J. D. Lubahn; General Electric Review, V. 50, Feb. April , pp. 28-32, 44-50.

The combined effects of temperature, strain, and strain rate upon the stress which will cause plastic flow are anlayzed in an attempt to make possible the prediction of flow characteristics which can be expected from a metal under a given combination of those factors. An expression of this nature is derived from relations between stress and strain, stress and strain rate, and temperature and strain rate. (This expression is corrected in a later paper by J. D. Lubahn, Jnl. of Applied Mechanics, ASME Trans. 1947, V.69, pp. A229-230). Evidence is offered to prove that the stress for additional strain is independent of the conditions which caused the prestrain and depends only upon the amount of that prestrain and the conditions prevailing for the subsequent test.

United States 1947 Theory

DERIVATION OF STRESS, STRAIN, TEMPERATURE, STRAIN RATE RELATION FOR PLASTIC DEFORMATION, J. D. Lubahn; Jour. Applied Mechanics, V. 14, Sept. pp. A229-230.

The derivation and correction of an equation for the stress for plastic flow as a function of the temperature, strain, and strain rate is presented. The correction refers to the equation as previously presented in a paper by J. H. Hollomon and J. D. Lubahn.

United States 1947 Theory

STRESS RUPTURE OF HEAT RESISTING ALLOYS AS A RATE PROCESS, E. S. Machlin and A. S. Nowick; Metals Technology, V. 14, No. 2, February, 13 pp. Also AIME TP No. 2137.

The theory of rate processes developed by Eyring and others is applied to the evaluation of stress rupture for the case of three heat resistant alloys. An equation is derived that gives, for a given composition and structure, the dependence of the time for rupture on stress and temperature.

The basic assumption of rate process theory is that the initial reactants and the activated complexes are always in equilibrium. Statistical mechanics yields the equation: $r = \frac{kTe^{-\Delta Fa/kT}}{h}$ where r is the rate of the reaction, ΔFa is the free energy of activation, T is the temperature, k is Boltzmann's constant, and h is Plank's constant. ΔFa is increased or decreased by $\beta\tau$ for r in the positive and negative directions respectively where τ is the applied shear stress and β is a temperature dependent factor. The stress rupture time t_r is inversely proportional to r_f where $\frac{A+BT-D\sigma}{T}$ where A and and B are constants of structure and composition, σ is temperature, and $\log D = E + FT$ where E and F are also constants of structure and composition; the relation of D to T was obtained empirically. For practical applications, the constants A, B, E and F are obtained experimentally. Thus for a given metal, t_r is obtained in terms of σ and T. For the three alloys tested, it was found that the equation predicted accurately the test results; the dependence of the time of rupture on the stress and temperature was verified. Therefore, the equation is useful for the interpolation and extrapolation of data in the ranges of temperature and stress, where test data are inconveniently obtainable. Since both β and the apparent free energy of activation $\Delta Fa(=\Delta Fa + kT \log_e c)$ have the same value for transcrystalline and intercrystalline failure, it appears that both types of failure are caused by the same rate process mechanism, and that a correlation exists between creep and stress rupture.

Since the equation obtained shows the relation of the logarithm of rupture time versus stress, it follows that there is a theoretical basis for the use of semilog plots for stress rupture, in preference to the commonly used log-log plots.

United States 1947 THEORY

PREDICTING CREEP STRENGTH, P. G. McVetty, Metal Progress, v. 51 June p. 959-960.

Referring to the method for predicting creep strength proposed by Kelvin Sproule in the March issue, the author suggests caution in any extrapolation to lower temperatures.

United States 1947 Theory (?)

CORRELATION OF TENSION CREEP TEST WITH RELAXATION TESTS, Poper, E. P., Jour. of Applied Mechanics, Trans. ASME Vo. 69, June, P.A. 135-A-142.

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United States 1947 THEORY

DISLOCATION THEORY AS APPLIED BY N.A.C.A. TO THE CREEP OF METALS, A. S. Nowick and E. A. Machlin; Jour. Applied Physics, V. 18, No. 1, pp. 79-87.

An equation for the steady state rate of creep in pure annealed polycrystalline metals is derived on the basis of the dislocation theory and of the theory of rate processes.

The dislocations are generated by the formation of an activated complex configuration in a small region. The rate of generation is shown to be the rate determining process. Limitation of the direction of motion of large groups of atoms results in the presence of a large negative entropy of activation for the process. When originally generated, the dislocations are probably just one atom long. The lowering under stress of the potential energy barrier is calculated in terms of "back-stress" and of the constants of the material. The creep equations yield calculated values which match closely the experimental data for Al, Cu, Fe, Sn, and Zn.

United States 1947 THEORY

PREDICTING CREEP STRENGTH IN METALS, Kelvin Sproule; Metal Progress, V. 51, No. 3, March, pp. 441-442, 440B.

The stress-temperature curves of many common metals and alloys are sufficiently parallel. After the construction of a chart containing information on other nonferrous metals, a rough stress-temperature curve for copper alloys can be obtained. This is done by drawing a line parallel to the trend, with any known value as a starting point.

United States 1947

STRESS RUPTURE CHARACTERISTICS OF VARIOUS STEELS IN STEAM AT 1200°F, J. T. Agnew, G. A. Hawkins, and H. L. Solberg, Engineering Experiment Station, Purdue University Research Series No. 101, May, 62 pps.

An investigation inwhich small tensile specimens made from low-carbon; C-Mo; 2-1/4% Cr-1% Mo; 5% Cr-Mo-Si; 9% Cr-Mo-Si; 12% Cr; 18% Cr-8% Ni; 25% Cr-20% Ni; and 5% Cr-Mo-Ti ~~xxx~~ steels, were placed in a steam reaction chamber at 1200°F. and stressed in tension for periods of time ranging from 10 hours to 7700 hours. Time to rupture, elongation, reduction in area, depth of scale layer, and type and angle of fracture. 33 ref.

United States 1947

STABILITY OF STEEL AT ELEVATED TEMPERATURES, A. B. Wilder and J. D. Tyson, Steel, v. 121, Oct. 20, p. 86-89, 108, 111.

Scope of extensive research program being conducted on high temperature piping materials at National Tube Co., Lorain, Ohio.

United States 1947

CAST HEAT RESISTANT ALLOYS OF THE 26% Cr-20% Ni TYPE, PART I, Howard S. Avery and C. R. Wilks, American Society for Metals Preprint No. 16, 1947, To be published in Trans. for 1948.

Data cover: mechanical properties at room temperature; stress-rupture and creep properties from 1200 to 2000°F; thermal expansion; resistance to carburization and hot gas corrosion; and several miscellaneous properties. The HK grade is suggested for general hot-gas corrosion resistance. It is also well suited for carburizing service when fortified with about 2% silicon.

16% Cr - 35% Ni
type alloys

United States 1947

CAST HEAT RESISTANT ALLOYS OF THE 16% Cr 35% Ni TYPE, Howard Avery and Norman Matthews; Trans. ASM, V. 38, pp. 957-1022.

An extensive analysis of the properties and performance characteristics of the "HT" type cast alloys is presented (and significant comparisons are made with the "HH" type alloys) as an aid in determining the applications in which they might offer superior service. The "HT" alloys were found in general to have superior creep strengths at 1400°F (about 8000 psi for 0.0001% per hour) but showed about the same creep strengths as the HH alloys above 1600°F. Although the "HT" alloys were less resistant to attack by hot reducing sulphurous gases, they had better resistance to carburization, and had superior hot ductility for increasing carbon content.

The effect of restrained contraction due to cyclic temperature service is discussed with emphasis upon the resulting thermal fatigue.

United States 1947

COBALT BASE AND NICKEL BASE ALLOYS FOR ULTRAHIGH TEMPERATURE, F. S. Badger, Jr and F. C. Kroft, Jr.; Metal Progress, V. 52, September, pp. 394-402.

This paper represents a collection of high temperature test data on a numl of cobalt-base and nickel-base alloys used during the war for critical portion: of high temperature equipment. These tests include aging, short-time tensile, stress-rupture, and carburisation tests. Tables, figures and photomicrographs are included.

Data on Al-Mg-Zn alloys

United States 1947

CREEP PROPERTY OF SOFT ALUMINUM-MAGNESIUM-ZINC ALLOYS AT TEMPERATURES FROM 90 TO 180°C, F. Bollenrath and H. Grober, Headquarters Air Materiel Command, Translation No. F-TS-1058-RE, Feb. 15 p.

Alloys with varying zinc and magnesium contents have been tested to determine their creep at temperatures from 90 to 180°C. At the same time, other physical properties were checked and it was found that copper improved the creep performance. Alloys rich in magnesium have poor creep.

Dalaov

Al

United States 1947

TENSILE STRENGTH OF ALUMINUM: EXPERIMENTAL DETERMINATION OF VALUE AT THE MELTING POINT, Giordano Bruni; Metal Industry, V. 70, No. 4, pp. 71-72.

The tensile strength of aluminum at 660°C was found to be 550 psi in the solid state. Both the annealed metal and rolled metal curves for tensile strength versus temperature converge toward that value at the melting point.

United States 1947

THE CREEP CHARACTERISTICS OF COPPER AND SOME COPPER ALLOYS AT 300, 400 and 500°F.
Burghoff, H. L. and Blank, A. I., ASTM Proc. V. 47 Pp 725-753, discussion p. 754.

Electrolytic copper, oxygen free copper, deoxidized copper, arsenical copper, red brass, admiralty, aluminum brass, Naval brass, 3% silicon bronze, phosphor bronze, 1.15 Ni, .23 P, 98.57 Cu alloy and 98.09 Cu, 1.11 Ni, 0.51 Te, 0.28 P alloy were tested. Creep data including total creep, creep rates and relative creep strengths are shown at 300, 400 and 500°F. Tensile properties and notations on mirostructure of the test materials before and after creep testing are given.

Test Results : --

I. The coppers - Of the four types of coppers, arsenical copper has the greatest creep strength. Deoxidized copper ranks second, and electrolytic copper and oxygen-free copper, whith have very close creep properties rank third, This order applies to both annealed and hard-drawn tempers.

The marked superiroity of the arsenical copper over the other coppers is largely derived from its much greater stability with regard to softening at elevated temperatures. The creep tests which were made on the deoxidized copper as stretched 1 and 6% after the final anneal are summarized. The effect of the 1% stretching is insignificant at all three test temperatures, but the 6% stretching produces a definite increase in creep strength, particularly at 300°F. The strengthening produced by the cold-work diminshes with increasing temperature of exposure.

II. Red Brass - The annealed material is shown to be superior to the two drawn tempers at 500°F.

III. Admiralty and aluminum brass - The creep characteristics for annealed tempers of these two alloys are similar to those of 70-30 brass. The tin and aluminum in these alloys contribute little creep strength in annealed tempers. The influence of grain size for the annealed alloy is insignificant. The creep properties of both alloys in drawn tempers are closely associated with their softening characteristics at the three elevated temperatures.

IV. Naval Brass - The creep rates for the two tempers of this alloy at 300°F are nearly equal ~~in~~ for stresses in the vicinity of 11,000 psi. For stress less than this the annealed material has the greater creep resistance. For stresses above 11,000 psi the drawn material has greater creep resistance. At 20,000 psi, the annealed metal had entered a stage of accelerating creep rate while the drawn material at 24,900 psi still extended at a decreasing rate at the end of the test period.

The stress-creep rate curve for the drawn temper of this alloy at 500°F shows an accelerating rate of creep.

V. 3% Si Bronze - Additional data agree very well with previously published wor k.

VI. Phosphor bronze - At 300°F the alloy as annealed is ... tly superior to

that as drawn for stresses below about 15,000 psi. For higher stresses the trend with respect to temper is reversed.

For stresses up to at least 10,000 psi at 400°F, the annealed material is definitely superior to that as hard drawn.

VII. Age-hardenable copper-nickel phosphorus and copper-nickel-phosphorus-tellunium alloys were found to have very high creep strength. Severe cold working of the copper-nickel-phosphorus alloy after heat-treatment produced the greatest resistance to creep. Both alloys are susceptible to embrittlement for conditions of exposure which are severe with respect to stress and temperature.

United States 1947

THE APPARENT INFLUENCE OF GRAIN SIZE ON THE HIGH TEMPERATURE PROPERTIES OF AUSTENITIC STEELS, C. L. Clark and J. W. Freeman; Trans. A.S.M., V. 38, No. 19, pp. 148-179.

The effect of grain size on the high temperature strength characteristics of four Austenitic steels (18-8, 18-12 + Cb, 25-20, and 25-12) was determined from short-time tensile, creep, and stress-rupture tests at temperatures of up to 1800°F. Broad generalizations could not be made since the effect varied from one Austenitic steel to another and other changes (such as the appearance of an unknown phase) had a marked influence on the mechanical properties. Only slightly superior high temperature (above 1000°F) creep and stress-rupture strengths for the 18-8 alloy were obtained with large grains; however, for the other alloys tested, the coarser grained structures were many times stronger but less ductile than the fine grained steels. The author suggests that a better combination of high temperature strength and ductility might be possible if more information were available on the unknown phase which accompanies fine grains in these latter alloys.

Data on 5% Cr steels with Mo + Ti

United States 1947

STRESS-RUPTURE TEST OF 5% CHORMIUM STEELS WITH MOLYBDENUM AND TITANIUM, George F. Comstock. Metal Progress, v. 51 April, p. 610-611.

Questions the validity of information concerning the high-temperature strength of 5% Cr (Mo + Ti) steels, reported by C. L. Clark in December 1946 issue. Mr. Clark's reply is included.

United States 1947

NICKEL-CHROMIUM ALLOYS FOR GAS TURBINE SERVICE, G. A. Crawford, Transactions of the ASME, v. 69, Aug. p. 609-612.

Two nickel-base alloys for gas turbine applications at temperatures upto 1500°F and possibly higher. Inconel X is a wrought material, readily forged and welded, with high rupture strength at all temperatures. The second alloy is a cast material primarily suited for extended service applications requiring high creep resistance in the neighborhood of 1500°F.

United States 1947

A METALLURGICAL INVESTIGATION OF LARGE FORGED DISCS OF LOW-CARBON N-155 ALLOY, Howard C. Cross and J. W. Freeman; NACA Technical Note, No. 1230, April 20 pp.

A study of the creep properties of three large forged discs of low carbon N-155 at room temperature, 1200°, 1350°, and 1500°F. One disc was tested in the as forged condition, the other two in the solution treated and aged conditions. At 1200°F the as forged disc has properties superior to those of the other discs. At 1350°F, the properties are almost equal, particularly at the lower stresses. At 1500°F the heat treated and aged discs are superior, particularly at the lower stresses where the deformation rates are small. Aging at 1350°F rather than at 1500°F produces higher strengths; some of the beneficial effects still remain at 1500°F.

The impact strength and ductility decreased after creep testing at 1200°, 1350°, and 1500°F. The tensile strength increased after creep testing at 1200° and 1350°F, but decreased slightly after creep testing at 1500°F.

 Data on Steels

United States 1947

EVALUATING HIGH HEAT PROPERTIES OF STEELS, Herbert Dobkin, Steel, v. 120, April, p. 86-87, 120, 122, 124.

The significance and methods of measuring elevated-temperature properties of various steels; the type of matérials generally used in high-temperature applications.

United States 1947

Cobalt-base alloys

THE DEVELOPMENT OF A TURBOSUPERCHARGER BUCKET ALLOY, E. Epremiam; Trans. ASM V. 39, No. 1, pp. 261-280.

In order to obtain an alloy which would be suitable for the high temperature, high stress service required of turbosupercharger and gas turbine buckets, the effect of variations in the amounts of chromium, nickel, tungsten, and molybdenum in cobalt-base alloys was determined. The composition of an optimum alloy was determined; designated as X63, it had the following composition: C 0.4-0.5%, Mn 0.5%, Si 0.5%, Cr 0.25%, Ni 10%, Mo 6%, Co balance. This alloy, chosen on the basis of rupture test data, was subjected to additional tests, to determine tensile strength (70,000 psi at 1500°F) and ductility (12% elongation for one inch at 1500°F), impact strength of 1/4 inch unnotched Charpy bar (25 ft.lbs. at 1500°F), coefficient of expansion (18.4×10^{-6} in/in/°C) thermal conductivity, specific gravity, hardness, creep resistance, damping capacity, fatigue strength, and oxidation corrosion resistance.

Dataon ?

EQUIP

United States 1947

HIGH TEMPERATURE DISK FORGING DEVELOPMENTS FOR AIRCRAFT GAS TURBINES, L. B. Fonda, Steel Processing, v. 33, Aug. p. 469-473, 486, 491, 500-502.

Type 1-40 turbine wheel, with its buckets, comprises the high temperature rotating parts of the jet engine powering the P-80 airplane. Bursting tests on turbine wheel blanks and bucketed turbine wheels. Circumstances behind this investigation, the type of equipment used, the various alloys and forging proctices investigated, and comparison of the results.

United States 1947

AN INVESTIGATION OF THE HIGH TEMPERATURE PROPERTIES OF CHROMIUM BASE ALLOYS AT 1350°F, J. W. Freeman, E. E. Reynolds, and A. E. White: NACA, Tech. Note. No. 1314, May, 21 pp.

Five chromium-base alloys were rupture tested at high temperatures. The rupture strengths of 55 Cr - 25 Fe - 20 Mo and of 60 Cr - 25 Fe - 15 Mo are extremely high, that of the 55% Cr alloy being 73,000 psi at 1350°F. The 60% Cr alloy is promising as a turbine bucket alloy; it contains less than 0.05% carbon and about 0.6% silicon. The alloy can be machined and fabricated, and techniques have been worked out for the casting of buckets. The 55% Cr alloy has the drawback of possessing poor room temperature properties.

United States 1947

HEAT-RESISTANT ALLOYS FOR USE IN JET-PROPULSION ENGINES, J. W. Freeman, E. E. Reynolds and A. E. White; Jour. Aero. Science, V. 14, Dec. pp. 693-702.

Compositions and mechanical properties are listed for some twenty alloys. Their use is discussed.

United States 1946

CREEP TESTS ON SOME EXTRUDED LEAD AND LEAD-ALLOY SLEEVES AND TAPES, G. R. Gohn, S. M. Arnold, and G. M. Bouton; Proc. ASTM, V. 46, pp. 990-1024.

The report covers extensive creep tests with particular emphasis on long time (up to 70,000 hours), low stress tests. Test specimens were from commercial lead cable sleeves (of 6 different compositions) and from a number of experimental lead-alloy tapes. The tests were performed at 80-85°F (except for a very few at 20°F) on directly loaded flat specimens of 3" gage length. The authros found that for high stress use (above 750 psi) the 0.9 percent antimony and 3 percent tin alloys showed the greatest resistance to creep; however, for low stress applications chemical lead showed the best resistance. For a maximum stress of 100-150 psi the chemical lead specimens showed no measurable creep after 60,000 hours; all other alloys evidence some creep in that time even for very low stresses.

United States 1947

THE STRESS RUPTURE AND CREEP PROPERTIES OF HEAT RESISTANT GAS TURBINE ALLOYS, Nicholas J. Grant; Trans. ASM, V. 39, pp. 368-403.

A large number of rupture and creep tests at 1500° to 1800°F (815° to 980°C) and at stresses from 7000 to 15,000 psi in creep and 15,000 ~~xxx~~ to 35,000 psi in rupture were made on a series of vitallium-base (cobalt-chromium-molybdenum) and nickel-chromium-cobalt-iron base alloys. The variables studied primarily were the effects of increasing amounts of carbon and nitrogen on the hot strength and ductility of these alloys, the role of heat treatment and aging, the relationship of the stress to the rupture time and to the minimum creep rate measured in both rupture and creep tests. An important relationship was shown to exist between time at temperature and the resultant ductility at fracture.

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Data on
Co-Cr-Mo-Ta
alloys

United States 1947

STRUCTURAL VARIATIONS IN GAS TURBINE ALLOYS REVEALED BY THE STRESS-RUPTURE TEST, Nicholas J. Grant, Trans. Amer. Soc. Metals, v. 39, p. 335-359.

In order to determine why occasional cast high-temperature, high-strength, alloys of the Co-Cr-Mo-Ta system failed to produce consistent results, the effect of the mold preheat and metal-casting temperatures on rupture properties was studied in precision investiment casting. A distinct relationship exists among the casting temperature of the mold and metal, the structufal variables of the alloy, and rupture and ductility properties.

United States 1947

Grant, N. J., Trans. ASM 39, p. 281

Cobalt-base alloys.

Data on 16-25-6 alloy

United States 1947

SUPERALLOYS, PART I. Walter G. Hildorf, Western Machinery and Steel World, v. 38, Aug. p. 88-91.

Requirements for superalloys for high-temperature use in gas turbines, (to be continued).

Data on 16-25-6 alloy

United States 1947

SUPERALLOYS, PART II, Walter G. Hildorf, Western Machinery and Steel World, v. 38, Sept. p. 126-129.

Concludes summary of the properties of 16-25-6 alloy (16% Cr, 25% Ni, 6% Mo) as affected by various treatments. Some of the properties are charted and tabulated in comparison with other high-temperature alloys.

Cr-Ti

Timken alloy

United States 1947

ALLOYS FOR SEVERE HIGH TEMPERATURE SERVICE, W. C. Leslie and D. J. McPherson, Engineering Experiment Station News (Ohio State University), v. 19, Dec. p. 42-47.

Past developments. Work at Ohio State on Timken 16-25-6 alloy (Cr-Ni-Mo steel) and on Cr-Ti binary alloys.

United States 1947 THEORY

T. S. Ke; Phys. Rev. 71, p.533.

Torsion creep of pure aluminum with reference to grain boundary relaxations.

Dalmon
3S-H Al alloy

United States 1947 Theory

CREEP DEFLECTIONS IN COLUMNS, Joseph Marine; Jour. Applied Physics, V. 18, No. 1, pp. 103-109.

A rational theory of creep deflection in columns is applied to the interpretation of preliminary tests on a 3S-H aluminum alloy column. An equation for the maximum creep deflection is given in terms of the load, time, column length, flexural rigidity, creep rate, and initial deflection. The calculated values are in agreement with the experimental data.

United States 1947

CREEP IN HOT VALVE SPRINGS, Alberto Oreffice and Luigi Locati, Metal Progress, c. 51, Feb. p. 269-270.

Creep behavior of small helical steel springs under special applications exists at 175°F. Its effect is revealed in the loss of load in needle valve springs in the fuel injector of diesel engines. Average test readings of four types of spring wire, after coiling and pretreating in various ways.

Data on
?

United States 1947

THE METALLURGICAL ASPECTS OF GAS TURBINE WHEELS AND NOZZLES. E. M. Phillips, Society of Automotive Engineers Preprint, Oct. 12 pps.

History of the development of satisfactory alloys. Tables and charts show comparative properties and photomicrographs show satisfactory structures.

Data on "High Temp." alloys

United States 1947

THE 1350° F. STRESS RUPTURE PROPERTIES OF TWO WROUGHT ALLOYS AND THREE CAST ALLOYS, E. E. Reynolds, J. W. Freeman, and A. E. White. National Advisory Committee for Aeronautics Technical Note No. 1380, Nov. 23 p.

Rupture-test characteristics determined for two wrought alloys, NR-82 (6059 modified low carbon) and NR-84 (M-155 modified low carbon); and three precision-cast alloys, NR-71 (X-40), NR-87 (Co-Cr-Ni base, 9% Mo) and NR-90 (Co-Cr-Ni base 5% Mo, 5% W). The two wrought alloys were tested in the solution treated and aged conditioh and the cast alloys were aged before testing.

Data on
Mo-V ~~alloys~~
Cr-Mo alloys

United States 1947

SOME 1000 F° STEAM PIPE MATERIALS, Ernest L. Robinson, American Soc. for Mech. Eng. Advance Copy, Paper 47-"-74, 10 pgs. Available from General Electric Company.

Long-time creep and rupture test results on an Mo-V alloy in comparison with low Cr-Mo compositions.

United States 1947 Equip

HIGH TEMPERATURE METALS, L. N. Rowley and B. G. A. Skrotzki, Power, v. 91, Oct. p. 79-94.

Recent developments, beginning with a review of fundamental principles. Structure, properties, testing, temperature effects, and design. Typical compositions and properties.

Oatman (see notes)

United States 1947

PRECIPITATION-HARDENED ALLOYS FOR GAS TURBINE SERVICE. PART I, METALLURGICAL CONSIDERATIONS. PART II, DESIGN AND APPLICATION DATA, Howard Scott and R. B. Gordon, Transactions of the ASME, v. 69, Aug. p. 583-591; 593-599.

Selection of base alloy and hardening agent, choice of heat treatment for optimum properties, and the use of short-time tensile and creep rupture tests in evaluating the effects of composition and heat treatment variables. The creep rupture properties of K42B, Discaloy, Refractaloy 26, and Refractaloy 70 in the form of design curves for each alloy at one or more temperatures.

Data on
Haynes alloys

United States 1947

HAYNES ALLOYS FOR HIGH TEMPERATURE SERVICE, W. O. Sweeny, Transactions of the AMSE, v. 69, Aug. p. 569-580.

Physical properties of various alloys in the forged and cast form. Applications.

Data on
Al alloys

United States 1947

Flanigan, A. E, Tedsen, L. F and Dorn, J. E., Trans. AIME 171, pp 213.

Comparison of creep properties of fully hardened sheet specimens of three aluminum alloys.

[illegible]

United States 1947

HEAT RESISTANT ALLOY CASTINGS OF THE "HH" TYPE, E. F. Wilson, Alloy Casting Bulletin, Dec. p. 1-9.

The significance of certain specifications and test procedures, and available information on the properties of the "HH" type, which contains 25% Cr and 12% Ni.

Approved For Release 2003/12/04 : CIA-RDP80-00926A003100040001-4

United States 1947, 1948 Equip

JET ALLOYS TESTED BY RAPID SPINNING AT HIGH TEMPERATURES, Scientific American, V. 177, 178, No. 2, pp. 77-78; 79.

Discs of the alloy material are spun at 35,000 rpm at 1400°F until failure takes place.

United States 1947 Equip

WESTINGHOUSE USES NEW JET METAL TEST, Aviation News, v. 7, March p. 18.

New test method for high-strength heat-resistant alloys required for jet engines. Disks 1 ft. in diameter, and 1 in. thick are rotated at 35,000 rpm while being heated to 1400°F. This is continued until the disk flies apart.

United States 1947

CREEP AND CREEP-RUPTURE TESTING, G. V. Smith, W. G. Benz, and R. F. Miller, Steel, v. 121, Dec. p. 88-90.

Description of specimens, temperature controls, test stands, general procedures, and use of data. (Based on data presented at annual ASTM meeting, Atlantic City, N. J. June 1947).

United States 1947 ~~1948~~

CREEP AND CREEP RUPTURE TESTING, G. V. Smith, G. Bens, and R. F. Miller, American Society for Testing Materials, Proc. v. 47, p. 615-635.

Title only.

Approved For Release 2003/12/04 : CIA-RDP80-00926A003100040001-4

United States 1947 EQUIP.

MEASURING CREEP, G. R. Gohn, Bell Laboratories Record, v. 25, Aug. p. 311-313/

Creep measurement on sections of cable sheath.

England 1947 Theory Equip

OBSERVATIONS ON CONDUCTING AND EVALUATING CREEP TESTS, W. Siegfried; Jour. Iron and Steel Inst., V. 156, No. 2, June, pp. 189-207.

A description of sustained load tests on various high temperature alloys, including notched specimens.

The effects of testing time on deformation and on notch toughness are discussed. Notch toughness data are supplied for various steels.

England 1946-47 THEORY

THE CREEP OF METALS, E. Orowan, West of Scotland Iron and Steel Institute, Jnl. v. 54, p. 45-72, 93-96, dis. p. 83-92.

From the viewpoint of the physicist rather than that of the engineer or metallurgist. 50 ref.

England 1947 THEORY

Mott, N. F. and Nabarro, F.R.N; Report of Conference on Strength of Solids, Phys. Soc. London.

Theory

England 1947

MECHANICAL PROPERTIES OF METALS, N. F. Mott, Nature 160, Nov. pp. 696-698.

A general description is given on the mechanical properties of metals which were discussed at the conference in Bristol, England during July 2-9, 1947. The subject of interest are the theory on dislocations, plastic flow and precipitation.

On the theory of transient creep, Andrade's and Orowan's Equations are given and on the viscous creep the work of Zener, Wood and Tapsell are reviewed.

The following works on internal friction are reviewed:

1. Snolk's work on elastic after effect in iron.

2. Gukllet's experiment on gold-copper alloys.

3. Burger's discussion on recovery and recrystallization.

The following works on diffusion and precipitation are reported:

1. Meyering's work on the oxidation of silver containing aluminum in solid solution.

2. Guiner's analysis of usual types of precipitation.

England 1947

HIGH TEMPERATURE ALLOYS: DEVELOPMENT FOR GAS TURBINES, William Griffiths; Metal Industry, V. 71, No. 18, pp. 359-362.

The significance of creep curves is discussed in relation to actual service performance. The fracture time is usually a misleading concept in regard to the choice of a high temperature material; materials with low constant creep rates at the desired temperatures are best. The tertiary creep range should be avoided in actual service. Damping capacity and fatigue data are of importance in determining the choice of a high temperature material. Data are furnished on austenitic steels and on Nimonic alloys.

England 1947

CREEP, Andrade, E. N. da C., J. Phys. Radium, Ser-8, 8, 3-3-26 Nov.

This is a lecture in French to the French Physical Society. The author first reviews the phenomenon of creep from the physicists' and engineers' viewpoints and proceeds to discuss the interpretation in terms of the behavior of single crystals. The preparation and properties of single crystals are described, and the dislocation theories of Taylor, Becker and Orowan are reviewed.

England 1947

CREEP AND SOME CREEP RESISTING ALLOYS, G. Burns; Metallurgia, V. 36, June, pp. 63-65.

A general review of the high temperature creep of both ferrous and non-ferrous alloys.

England 1947

ANDRADE'S CREEP LAW AND THE FLOW OF ZINC CRYSTALS, A. H. Cottrell and V. Ayterkin; Nature, V. 160, No. 4062, Sept. pp. 328-329.

In order to apply Andrade's creep law to plastic flow for single crystals, several modifications in the apparatus are necessary. Notably, the shear stress acting on the glide planes in the glide direction must be maintained constant; therefore a lever device which relaxes the load as the specimen extends is used. Thus instead of obtaining constant load or constant tensile stress data, the results are directly and accurately obtained for constant shear stress. The results of tests on several zinc crystals in the form of wires are expressed in terms of shear strain (on the glide planes, in the glide direction) as a function of time of loading. The form of Andrade's equation for constant tensile stress is modified for constant shear stress to $Y = Y_0 + Bt^{1/3} + nt$, where Y is the total shear at time t, Y_0 is the instantaneous shear accompanying loading, and B and n are coefficients of flow.

Experimental results fit the equation closely, and for the case where $n = 0$, the variation of Y with $t^{1/3}$ is accurately linear.

England 1947

CHOOSING HEAT RESISTING MATERIALS, E. Barber, Machinery Lloyd (Overseas Edition) v. 19, July 19, p. 87-90.

Problems invoLed, and conditions and applications to be taken into consideration in choosing heat resisting materials.

England 1947

CREEP AND FATIGUE AS AFFECTED BY GRAIN BOUNDARIES, Charles Crussard; Metal Treatment, V. 14, Autumn, pp. 149-160.

An investigation of the influence of grain boundaries on the fatigue and creep properties of magensium and zinc.

England
~~[illegible]~~ 1947

CREEP RATE OF VARIOUS INDUSTRIAL LEADS, J. Neill Greenwood and J. H. Cole; Metallurgia, V. 36, September, pp. 233-235.

The effects of traces of Cu, Bi, Cd, Sn, Sb, As, Fe, Zn, S, Ni, Ag, and Co in Pb were investigated in relation to the creep rate; some impurities increased the creep rate while others decreased it, but the changes were not necessarily progressive. Refined industrial leads were compared to synthetic samples in regard to their creep rate. It was found that the total impurity content of industrial lead is no guide to behavior under prolonged stress. A 100 day test under a stress of 500 psi is suggested for classification purposes, with the time to 2% extension as a criterion.

England 1947

ABNORMAL CREEP IN CARBON STEELS, J. Glen; Jour. Iron and Steel Inst., V. 155, April, pp. 501-512.

Short time creep tests have been carried out on fine grained low-carbon steels containing 0.4 - 1.5% Mn, 0.01 - 0.15% Si, and 0 - 0.11% Mo; the Al content did not exceed 3 lbs./ton. A uniform ferritic grain-size was maintained. Creep data were taken at 450°C with a stress of 8 tons/sq.in. for five days. The results indicate that the alloying elements Mn, Si and Mo reduced the creep rate thereby counteracting the abnormally high creep resulting from the aluminum additions. Aluminum may be used as a deoxidizer in coarse-grained steels without the additions of Mo, Mn, and Si, since the creep rate is abnormally large only in the fine-grained steel.s

Data on C. steels

England 1947

CORRESPONDENCE ON THE PAPER - ABNORMAL CREEP IN CARBON STEELS, Jnl. of the Iron and Steel Institute, v. 157, Dec. p. 579-586.

Correspondence of W. B. Brooks, W. E. Bardgett and H. W. Kirkby, relative to paper by J. Glen (April 1947 issue). Bardgett's contribution consists of extensive experimental data on effect of treating with Si with no Al additions; effect of treating with Al with no Si additions; and effect of treating with Al in the presence of Si. Author's replies.

Order on
"High Temp."
[illegible]

England 1947

BRITISH HIGH TEMPFRATURE STEELS FOR GAS TURBINES, C. Cyril Hall. Steel, v. 120, June 23, p. 101, 132.

Properties of the alloys.

Data on Ti steels

England 1947

SOME PROPERTIES OF TITANIUM STEELS, L. Northcott and D. McLean, Jnl of the Iron and Steel Inst. v. 157, Dec. p. 492-512.

The effects of up to 6% Ti on the structure and properties of plain carbon steel containing 0.1 to 1.0% C, and four low-alloy steels (Cr, Mo, Mn, Mo, Cr, Ni) were investigated. Vertical sections showing the constitution of the Fe-Ti-C system at constant Ti contents were prepared from the results of micro-examination, hardness tests, and thermal analysis. Results of tensile tests at room and at elevated temperatures, in conjunction with hardness tests on quenched and tempered specimens are summarized. Results of other workers on the elimination of quench and strain-age hardening by Ti have been to a great extent confirmed.

Austenitic steels

England 1947

HIGH CREEP STRENGTH AUSTENITIC GAS-TURBINE FORGINGS, D. A. Oliver and G. T. Harris, Engineer, v. 183, May, p. 468-469.

Characteristics required for gas-turbine use. The properties and chemical compositions of five British steels. Special problems in the melting, casting, forging, heat treating, machining, inspection, and testing of solid rotor forgings. (To be continued) (Condensed from paper presented to Institute of Marine Engineers, April, 1947).

Data on
Aust. steels

England 1947

HIGH CREEP STRENGTH AUSTENITIC GAS TURBINE FORGINGS (CONCLUDED) D. A. Oliver and G. T. Harris, Engineer, v. 183, June 6, p. 502-503.

Results of experimental work on creep of G.18B and R.20 steels. The use of creep data for solid rotor forgings and the present state of gas turbine development from the metallurgical point of view. General observations on the creep testing of materials at elevated temperature. (Condensed from paper presented to Institute of Marine Engineers, April 1947).

England 1947

Aust. steels
+
Nimonic 80

GAS-TURBINE FORGINGS - DEVELOPMENT OF HIGH-CREEP STRENGTH AUSTENITIC STEELS, D. A. Oliver and G. T. Harris; Iron and Steel, V. 20, No. 7,8, pp. 333-336, 339-344.

Tensile, creep, and fatigue data at room and at elevated temperatures on austenitic steels and Nimonic 80.

England 1947

Oliver, D. A. and Harris, G. T.; Trans. Inst. Mar. Engrs. 20, pp. 333, 339

Development of new creep resistant austenitic steels by William Jessop and Sons, Ltd.

England 1947

METAL CREEP, A. H. Sully, Research, Vol 1.

England 1947

Sykes, C.; Second Hatfield Memorial Lecture, J. Iron and Steel Inst. 156, p 321.

Austentic steels developed by Crown-Firth Research Labs.

England 1947

Zschokke, H. R. and Niehus, K. H.; J. Iron and Steel Inst. 156, p. 271.

Optinum value of cold work relative to subsequent creep properties of austenitic steel in range 550–750°C.

England 1947

BIBLIOGRAPHY ON CREEP AND HEAT RESISTING STEELS (COVERING THE PERIOD 1937 to 1947)., Jnl. of the Iron and Steel Institute, v. 156, July, p. 338-369.

Bibliography compiled in connection with paper on steels for use at elevated temperatures, by C. Sykes.

Dilation ?

France 1947 Theory

CREEP AND FATIGUE AS AFFECTED BY GRAIN BOUNDARIES, Charles Crussard, Metal Treatment, v. 14, Autumn, p. 149-160.

Work on the roleof grain boundaries in creep and fatigue with particular reference to the hexagonal metals, zinc and magnesium. 18 ref. Presented at meeting of La Societe Francaise de Metallurgie.)

Germany 1947 Therm.

CALCULATION OF THE TENSILE STRENGTH OF METALS AND ITS DEPENDENCE ON THE RATE OF LOADING AND TEMPERATURE, Albert Kochendörfer, Metallforschung, V. 2, No. 6, pp. 173-186.

The stress-strain curve and the tensile strength of face-centered cubic polycrystals are derived from single-crystal data, and in relation to the strain-rate and temperature. The method is applicable to body-centered-cubic materials even if no single-crystal data are available, but is not applicable to hexagonal materials in that case. Calculated values for copper and aluminum are in good agreement with the experimental data.

Data on
Cr-Mn-V Steel

Germany 1947

CREEP TESTS ON CHROMIUM MANGANESE VANADIUM STEEL ALLOYS, Paul Even, Headquarters Air Materiel Command, Wright Field, Translation F-TS-1864-Re, Sept. 3 p. (Translated from report of B.M.W. Flugmotorenbau B.mbH. March 1945).

Temperatures of exhaust-gas turbine blades were reduced by cooling to approximately 500 to 620°C. Based on this reduction in temperature, tests on blades of Cr-Mn-V steel alloys were made. Creep tests for 100 hr. showed 1% total elongation.

Germany 1947

THE CREEP BEHAVIOR OF SOME ALUMINUM AND MAGNESIUM ALLOYS AT TEMPERATURES BETWEEN 90°C and 180°C, Franz Bollenrath and Hanns Gröber; Metallforschung, V. 2, No. 4, pp. 104-111. Translation: Headquarters Air Materiel Command, No. F-TS-1058-Re. February, 15 pp.

300 hour tests of 4% Cu, 1% Mg aluminum alloy; 1-6% Mg, 2-7% Zn aluminum alloy; 9.5% Si aluminum alloy, 5.85% Al, 2.59% Zn magnesium alloy, and 8.53% Al, 0.5% Zn magnesium alloy. The aluminum alloys were wrought; the magnesium alloys were cast. It was found that the tensile properties of the aluminum alloys after creep, were markedly dependent on the creep test temperature. Becker's relation between stress and temperature for a given creep rate was shown to be inapplicable. The creep properties of the alloys containing copper were found to be superior to those of the copper-free alloys at temperatures above 120°C; the magnesium-rich alloys were found to have a low creep resistance at the higher temperatures.

Germany 1947

Data on Zn + Zn alloys

Messner, O.H.C.; Ukerdie DauerStandfeztgkeit von Zunklegierungen.

Creep properties of zinc and its alloys.

Obtain
Co-base
alloys

Canada 1947

THE DEVELOPMENT OF A TURBO-SUPERCHARGER BUCKET ALLOY, E. Epremian, Canadian Metals & Metallurgical Industries, v. 10, Jan, p. 22-25-31

Experimental data obtained in the development of a cobalt-base alloy for turbosupercharger bucket application. (Paper presented to American Society for Metals, November 1946).

Canada 1947 Equip

HIGH TEMPERATURE TESTING, PART I., W. E. Kuhn, Canadian Metals and Metallurgical Industries, v. 10, May, p. 20-22, 43.

The effect of high temperature on metals and how to plan an intelligent test program. (To be continued).

Puta... steel

Italy 1947

LE PROVE DI SCORRIMENTO INTERROTTE. INFLUENZA DELLE INTERRUZIONI DI SOLLECITAZIONE E DI RISCALDAMENTO SULLE PROPRIETA DI SCORRIMENTO. (An Interrupted Creep Test. Influence of Interruption of Heating and of Application of Load on the Process of Creep). L. Matteoli and B. Andreini, La Metallurgia Italiana, v. 39, March-April, p. 71-81.

Effects of simultaneous and of separate brief interruptions of the above were investigated for a steel contaning 0.20% C, 0.71% Mn, 0.78% Cr, and 0.27% Mo. A 150-hr. and a 1000-hr. test at 500°C were applied.

Netherlands 1947

DE ONTWIKKELING VAN DE KRUIPVASTE STAALSOORTEN (Development of Heat Resistant Steels) A. J. Zuithoff, Metalen, v. 1. April. p. 133-138.

The development of various heat resistant steels with special attention to the improvement in strength at high temperatures during the past five years of alloys for turbosuperchargers and aricraft gas turbines.

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Japan 1947

BRITISH INTELLIGENCE OBJECTIVES SUB COMMITTEE, Japanese Metallurgy, High Temperature Alloys for Gas Turbines, Rocket Nozzles and Lines. (Report No. BIOS/JAP/PR/583) Cr. 4to pp. 12, London H.M. Stationery Office.

Russia 1947 THEORY

VARIABILITY OF THE STRESSED STATE OF MATERIALS IN TIME, Rzhanitsyn, A. R., J. Tech. Phys. USSR 17, No. 7, pp. 491-6, (In Russian) copy from Physics Abs. 1684, 1948.

A study is made of the behavior of bodies displaying creep characteristics, from the standpoint of arbitrary representation of the structure, for a non-uniform substance occupying the pores of the main structure. In contrast to the usual representation of absolute elasticity of the solid framework, providing a linear relationship between stresses and deformations, and clarifying only the reversible processes, the solid substance of the body takes on properties characteristic of non-elastic bodies. Consequently, several well-known facts concerning the behavior of plastic-elastic bodies under alternating stress can be simply interpreted. A graphical solution of the problem is given.

Russia 1947 Theory Data 7

A STUDY OF THE RELATIONSHIP BETWEEN RESISTANCE OF METALS OR AMORPHOUS BODIES TO PLASTIC DEFORMATION ANDTHE SPEED AND TEMPERATURE OF DEFORMATION, L. D. Sokolov; Zhur. Tekhn. Fiziki (In Russian) V. 17, No. 5, pp. 543-548.

An investigation of the true stresses produced in a variety of metallic and non-metallic materials when subjected to static and dynamic compression tests at various temperatures.

 Batam Al alloys

Russia 1947 THEORY

DEPENDENCE OF THE HEAT RESISTANCE OF ALUMINUM ALLOYS ON THEIR COMPOSITION AND STRUCTURE, (In Russian) A. A. Bochvar, Izvestiya Akademii Nauk SSSR Otdelenie Tekhnicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR, Section of Technical Sciences, Oct. p. 1369-1384.

A papid auxiliary method for high-temperature performance determination is proposed, based on the gradual change, with time of loading, of the size of impressions obtained by forcing a macro or micro-indenter under constant load into the specimen. On the basis of data obtained by the above method and also by standard creep testing, it is believed that the heat resistance of alloys results from heterogeneity of their crystal structures, and also may be caused by the formation of screen or skeleton-like inclusions of solid phases on the grain boundaries.

Russia 1947 THEOR-1

Fe-Cr-Al

Zharouporny Splav. (Heat Resisting Alloys), (BOOK) Vol. 3, I. I. Kornilov. 120 pps. Academy of Sciences of the USSR, Moscow, USSR.

Results of theoretical and experimental investigation of the most important factors in developing heat-resisting alloys. Solid solutions of iron with a series of alloying elements were studied thoroughly, particularly regions of the constitution diagram which include heat resistant materials. It is shown that the ternary system Fe-Cr-Al represents the most important combination of elements for use between 800 and 1500°C. Two alloys have been developed and introduced industrially in the USSR, replacing the Ni-Cr alloys and platinum. 48 ref.

Russia 1947 Equip

NOTCH IMPACT TESTING OF STEELS AND ALLOYS AT HIGH TEMPERATURES (In Russian)
A. B. Al'tman and G. V. Estulin. Zavodskaya Laboratoriya (Factory Laboratory), v. 13, Oct. p. 1218-1221.

A specially designed furnace and testing apparatus. Results of testing of carbon steel, with and without 0.1% Pb, from 800 to 1200°C, and of 18-8 stainless steels containing Ti, and also W, at 20, 600 and 700°C.

United States 1949 Theory

CORRELATION OF TENSILE CREEP TEST WITH RELAXATION TESTS, Irving Roberts; Jour. Applied Mech., V. 16, June, p. 208.

This paper shows that analytical solutions to the bolt relaxation problem, based upon empirical creep data equations, may be obtained by direct substitution rather than by differentiation and integration, as was doen by Soderberg (Trans. ASME, V.58, 1936, pp. 733-743) and by Popov and Housner (Jour. Applied Mech. 1947, p. A-135 and p. A-352).

United States 1948 THEORY

PLASTIC FLOW, CREEP, AND STRESS RELAXATION. IV * ANOMALOUS FLOW AS AN ORDER* DISORDER TRANSITION, Charles Mack; Jour. Applied Physics. V. 19, No. 11, Nov. pp. 1082-1091.

Plastic systems show effects of steric hindrance at rest, which results in a molecule preventing its neighbors from occupying certain positions and introduces a certain degree of orientation. Under stress many more positions, resulting from the rotation, are forbidden to a molecule in motion. In order to make more positions available, it is necessary for the system to increase its volume under stress, and a change from a state of greater order to one of greater disorder results. Based on this concept, equations relating the strain-rate at constant temperature to the stress, change in volume, and degree of order-disorder are developed. The changes in entropy and interaction energy accompanying the strained state, are expressed by a generalized partition function. This concept of anomalous flow is extended to visco-elastic effects for systems with rubber-like elasticity.

United States 1948 THEORY

J. G. Leschen, R. P. Carreker and J. H. Holloman; Metals Tech. Pub. 2476.

Theory on nucleation and growth of slip bands.

US
~~England~~ 1948 Theory

R. D. Heidenreich and W. Shockley; Report on Conference on Strength of Solids, p. 60, Phys. Soc., London.

Study of slip bands in creep.

United States 1948 Theory

ON CREEP AND RELAXATION- II, B. Gross; Jour. Applied Physics, V. 19, No. 3, March, pp. 257-264.

In a previous paper the theory of transient effects, caused by the sudden application of a constant load or a constant deformation, was presented. In the present paper, the theory of steady-state behavior under alternating load and deformation is developed. The principle of superposition is used in order to formulate a phenomenological theory of the elastic aftereffect. Relations are established between the loss factor, the storage factor, the distribution functions, and the Laplace transforms of the creep and the relaxation functions.

The dynamic equation of motion of the vibrating body is established on the basis of the mechanical properties of the system, and of the stress-strain relation which is governed by the principle of superposition.

United States 1948

CAST HEAT-RESISTANT ALLOYS OF THE 26% Cr-20% Ni TYPE, Howard Avery and Charles Wilks; Trans. ASM, No. 16, pp. 529-581.

The 26% Cr - 20% Ni cast alloys have been examined. The room-temperature mechanical properties, the carburization and corrosion resistance, and the stress rupture and creep properties in the 760-1095°C temperature range are discussed.

United States 1948 THEORY

Data in Pb, Cu + Al

TRANSIENT PLASTIC DEFORMATION, R. P. Carreker, J. G. Leschen and J. D. Lubahn; Metals Technology, V. 15, No. 6, Sept. 8 pp. (AIME TP No. 2477).

Experiments we e undertaken to confirm the existence of transients in the strain rate which occur whenever the applied stress is suddenly changed from one stress level to another; the discontinuity in the strain rate is followed by a gradual approach to an equilibrium value. Creep tests were carried out on lead, copper, and aluminum, and the strain rate was measured optically. In addition, stress-strain and strain-time curves were obtained from tensile tests conducted on similar specimens.

The results indicate that the magnitude of the transients may be quite large. Cydic loading produced more deformation than the maximum lead employed would have produced during the same period of time. It is to be expected that as the length of the cycles becomes greater than the duration of the transients, the effect of the transients becomes less important. The mechanical equation of state is shown to be a special case of the nucleation theory which successfully predictied the transient.

United States 1948

AN INVESTIGATION OF CREEP FRACTURE, AND BENDING OF LEAD AND LEAD ALLOYS FOR CABLE SHEATHING - SERIES 1946, Curtis W. Dollins, Univ. of Ill., Engineergin Experiment Station, Bulletin Series No. 378, July, 1. 90 pps.

Results of creep tests on strip and full sections of lead-cable sheathing. Lead alloys show considerable recovery during cyclic loading. Data are given which may account for the wide difference in the amount of creep obtained in laboratory test s and field tests. Stress-rupture tests in which loss of ductility as time for fracture is increased is very marked. Bending machines for testing the bending resistance of sheathing in strip form or extruded on cables. The marked superiority of the arsenical leads is shown by both strip and cable bend tests.

United States 1948 Theory

SOME EFFECTS OF APPLIED STRESS ON PRECIPITATION PHENOMENA, W. L. Finlay and W. R. Hibbard, Jr.: Metals Technology, V. 15, No. 6, Sept. 18 pp. (AIME TP No.2470).

It is believed that precipitation and solution shearing movements constitute structural weaknesses which might cooperate with applied stresses to facilitate plastic deformation. It is also believed that the hydrostatic pressure affects significantly the degree of disregistry across the matrix-precipitate interface and consequently affects the age-hardening.

Two binary systems were investigated, 12% Zn-Al and 4% Cu-Al. The effects of uniaxial tensile creep at high aging temperatures, and of hydrostatic pressure during aging at high temperatures were investigated.

It was found that solution shearing facilitates plastic deformation. It was shown that precipitation does not increase the tensile creep extension of 4% Cu-Al, but increases that of 12% Zn-Al, as does solution shearing. This, presumably because transformation mechanisms are complex in the former alloy, and simple in the latter; the 111 planes must participate in the shear in order for the creep extension to occur, and precipitation shearing must affect those planes in order to contribute to the creep. Hydrostatic pressure tests show that aging increases coherency (and hardness) in the 12% Zn-Al alloy and reduces coherency (and hardness) in the 75S Al alloy.

Data on
.5Cr-.5Mo
Pipe Steel

United States 1948

A STUDY OF THE PROPERTIES OF 0.5% CHROMIUM -0.5% MOLYBDENUM PIPE STEEL, R. C. Fitzgerald, A. B. Wilder, G. V. Smith, and A. E. White, Welding Jour., V. 27. Sept. pp. 457s-469s.

An investigation of the mechanical properties, including creep, and of the fabricating characteristics of this high temperature steel, reveals the properties and characteristics to be essentially the same as those of a 0.5% molybdenum steel. However, resistance to graphitization, to oxidation, and to embrittlement is good. Excellent creep properties were obtained in tests at 1000°F.

United States 1948

HIGH TEMPERATURE PROPERTIES OF ROTOR DISKS FOR GAS TURBINES AS AFFECTED BY VARIABLES IN PROCESSING, J. W. Freeman, H. C. Cross, and E. E. Reynodls and W. F. Simmons. American Soc. for Testing Materials, Advance Reprint from Proc. of the Amer. Soc. for Testing Materials, v. 48, 36 pps.

Results of high-temperature tests on 24 large forged disks of eight heat resisting alloys, both low and high alloy. Short-time tension, rupture, creep, and stress-time for total deformation characteristics were determined at 1200, 1350 and 1500°F. 14 ref.

Data on Inconel vitallium type etc. alloys

United States 1948

THE RUPTURE TEST CHARACTERISTICS OF HEAT RESISTANT SHEET ALLOYS AT 1700° AND 1800°F., J. W. Freeman, E. E. Reynolds, and A. E. White; NACA Tech. Note, 1465, Feb. 61 pp.

There are presented the rupture test characteristics at 1700° and 1800°F of standard chromium nickel type alloys, inconel alloys, vitallium type alloys, and other high temperature alloys.

Data on
Timken alloy

United States 1948

A METALLURGICAL INVESTIGATION OF FIVE FORGED GAS TURBINE DISCS OF TIMKEN ALLOY, J. W. Freeman, E. E. Reynolds, and A. E. White, National Advisory Comm. for Aeronautics, Tech. Note No. 1531, June, 55 pps.

Tests to determine reproducibility of properties of disks made by different companies and to investigate effect of various fabrication procedures on disk properties. Properties at room temperature and 1200°F. Tests included short-time tensile, stress-rupture, creep, and hardness, along with a metallographic examination of the materials before and after testing.

United States 1948

A METALLURGICAL INVESTIGATION OF TWO CONTOUR-FORGED GAS-TURBINE DISCS OF 19-9 DL ALLOY, J. W. Freeman, E. E. Reyndds, and A. E. White, Nat. Advisory Comm. for Aeronautics, Tech. Note. No. 1532, Sept. 37 pps.

Results of tests to determine the level of properties developed in large cohtour forgings of the alloy, to evaluate the effect of the temperature of hot cold work in these large forgings, and to show the degree towhich the properties of bar stock can be reproduced in large forgings.

Pattern
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United States 1948

A METALLURGICAL INVESTIGATION OF TWO LARGE DISCS OF CSA ALLOY, E. E. Reynolds, J. W. Freeman, and A. E. White, National Advisory Committee for Aeronautics, Tech. Note. No. 1533, Sept. 33 pps.

Results of a study of properties at room temperature and 1200°F. Aging treatment is beneficial to rupture properties, while no effect on tensile, hardness or time-deformation properties was observed.

United States 1948

Data on Plant Cut ??

THE EFFECT OF SMALL PERCENTAGES OF SILVER AND COPPER ON THE CREEP CHARACTERISTICS OF EXTRUDED LEAD, G. R. Gohn and W. C. Ellis; Proc. ASTM, V. 48, pp. 801-814.

Creep tests on extruded lead pipe specimens reveal that silver contents of up to 0.010% improve the creep resistance at stresses of 400 psi. and above, and that the higher the stress level, the greater the impfovement. The creep rate was not improved by the further addition of 0.061% copper, or by any further silver additions.

Data on
Co-Cr alloy

United States 1948

THE COBALT-CHROME J ALLOY AT 1350 to 1800°F, Nicholas Grant; Trans. ASM, V. 40, No. 17, pp. 585-616.

Using ordinary vitallium as a base, a new alloy (J alloy) has been developed which shows improved rupture properties in the temperature range from 1350°F to 1800°F. The optinum carbon content was established at about 0.76%; this optimum carbon alloy, when tested at 30,000 psi and 1500°F had a 500 hour rupture life. In addition to the higher strength, this alloy is more stable and is more easily reproduced than the previously reported Co-Cr alloys. The optimum aging for the J alloy requires five hours without load at 1350°F. The creep resistance of the J alloy is about the same as the creep resistance of the Co-Cr alloys previously mentioned; howver, its room temperature ductility is somewhat less.

United States 1948

A SUMMARY OF HEAT RESISTANT ALLOYS FROM 1200 to 1800°F., Nicholas J. Grant, A. F. Frederickson, and M. E. Taylor, Iron Age, V. 161, Marc. 18, 1948, p. 73-78, April 8, 1948, p. 75-81; April 15, 1948, p. 84-93.

Conducted as a project of the U. S. Navy Bureau of Ships, this summary correlates and evaluates data produced over the past seven years by various industrial and governmental sources. Relative stress-rupture data, and creep properties at various temperature levels. Compositions of some 53 alloys, together with physical property data for most of the alloys. Effects of temperature, grain size, composition, and aging on rupture and creep properties. The degree of control necessay to standardize these variasbles. Stress-to-rupture and elongation values for some of the more promising forged and cast alloys at various temperature levels. Relative mechanical properties of the 53 Alloys.

Orders on
Sheet
materials

United States 1948

SHEET METALS FOR HIGH TEMPERATURE SERVICE, P. A. Haythorne, Iron Age, v. 162, Sept. p. 89-95.

Results of experimental investigation prompted by frequently encountered warpage, buckling, and ultimate failure of metals currently being used in such assemblies as jet exhaust stacks, tail cones, combustion chambers, and exhaust manifolds. The effects of repeated flame impingement on common high-temperature alloys and composite (clad) materials.

United States 1948

DEVELOPMENT OF CAST ALUMINUM ALLOYS FOR ELEVATED TEMPERATURE SERVICE, Webster Hodge, L. W. Eastwood, C. H. Lorig, and H. C. Cross, National Advisory Comm. for Aeronautics, Tech. Note. No. 1444, Jan. 32 pps.

Effects of heat treatment and exposure to elevated temperatures on the tensile properties of various alloys subsequently cooled to room temperature; effects of various alloy additions on the room and elevated-temperature properties of 6% Mg aluminum alloys; and improvement in high-temperature creep properties.

Data on
Al alloys

United States 1948

TENSILE, FATIGUE AND CREEP PROPERTIES OF FORGED ALUMINUM ALLOYS AT TEMPERATURES UP TO 800°F, L. R. Jackson, H. C. Cross, and J. M. Berry; NACA Tech. Note No. 1469, March, 48 pp.

Data arepresented on the tensile strength, fatigue strength, creep properties, and thermal expansion of various forged aluminum alloys; the data are pertinent to the application of these alloys in the temperature range from 70° to 800°F.

Data on Mg with 0-10% Zn + 3rd Element

United States 1948

THE ROOM AND ELEVATED TEMPERATURE PROPERTIES OF SOME SAND-CAST MAGNESIUM-BASE ALLOYS CONTAINING ZINC, Thomas Leontis; Metals Technology, V. 15, No. 4, June, 35 pp. (AIME TP No. 2371).

An investigation of the tensile properties, hardness and creep resistance of Mg-Zn alloys. At temperatures up to 500°F, the properties improve progressively with increasing Zn content in the composition range of 0-10% Zn, and particularly in the range of 0-6% Zn. Further improvement is achieved by the addition of a third element such as Al, Cd, Ca, Sn, Ce, Mn, Ag and Zr, or by the addition of a combination of such elements. Zr or Mn additions produce alloys with excellent tensile and creep properties which are superior to presently used commercial sand casting alloys AZ92-HTA and AZ63-HTS at high temperatures, and which furthermore are not inferior to those alloys at room temperature; these alloys contain 6% Zn and either 1% Zr or 1/2% Mn. Mg-Ce alloys, however, have superior high temperature properties, but have little ductility and poor room temperature properties.

United States 1948

EFFECT OF TEMPERATURE OF COLD ROLLING, TEMPERATURE OF TESTING AND RATE OF PULLING ON TENSILE PROPERTIES OF AUSTENITIC STAINLESS STEELS WITH LOW NICKEL CONTENT, R. A. Lincoln and W. H. Mather, American Iron and Steel Institute, 22 ppgs discussiorn p. 17-22.

Deals with alloys containing approximately 18% Cr and a little less than 7% Ni. Includes extended discussion by D. C. Buck.

Data on steel

United States 1948

CREEP OF STEEL AND CONCRETE IN RELATION TO PRESTRESSED CONCRETE. Gustave Magnel, Jnl. of the American Concrete Institute, v. 19, Proc. v. 44. Feb. p. 485-500.

Methods and results of creep tests performed on three different samples of steel wire under constant load and constant length conditions. Preparation of concrete specimens prestressed by use of these same wires.

Data on low-alloy steels

United States 1948

THE STRUCTURAL STABILITY OF SEVERAL CAST LOW ALLOY STEELS AT ELEVATED TEMPERATURES, V. T. Malcolm and S. Low, Trans. of the Amer. Soc. of Mech. Engineers, v. 70, Nov. p. 879-883.

Effects of furnace practice on a cast C-Mo-V steel, and of Al, Cr, V, Cu, Ti, Ni, and high Mo on cast combinations. Results of Mc-Quaid-Ehn Tensile, Jominy hardenability, creep, and weldability tests. Structural stability after various aging cycles. Effect of aging at elevated temperature on static bend bars and V-notch Charpy bars.

United States 1948

TENSILE CREEP AND FATIGUE PROPERTIES AT ELEVATED TEMPERATURE OF SOME MAGNESIUM BASE ALLOYS, John C. McDonald, Amer. Soc. for Testing Materials. Advance Reprint from Proc. of the Amer. Soc. for Testing Materials, v. 48, 18 pps.

Tests on castings and forgings to be used in engines.

United States 1948

DETERMINATION OF STRESSES IN GAS TURBINE DISKS SUBJECTED TO PLASTIC FLOW AND CREEP, M. Millenson and S. Manson; NACA Tech. Note. No. 1636, June. 45pp.

The use of a finite difference met od in the computation of disk stresses under conditions of creep and plastic flow is illustrated. Numerical integration is thus avoided.

Data on
alloy steels

United States 1948

INTERMEDIATE ALLOY STEELS AT ELEVATED TEMPERATURES, R. F. Miller, Petroleum Engineer, v. 19, Jan. p. 178-180, 182, 184-186, 188-189.

Requirements for various applications, and data concerning the mechanical properties and elevated temperature corrosion resistance of ~~temperature corrosion~~ ten steels most commonly used in the petroleum industry. 19 ref.

Data on Pb with Ag + Cu

United States 1948

INFLUENCE OF SMALL PERCENTAGES OF SILVER ON THE TENSILE STRENGTH OF EXTRUDED LEAD SHEATHING, H. S. Phelps, Frank Kahn and W. P. Magee; Proc. ASTM, V. 48. pp. 815-840.

Stress rupture tests were conducted on a series of extruded cable sheathing lead pipe samples containing up to 0.018% silver. Optimum results were estimated to occur with 0.010% silver additions. The life was markedly increased, and the creep rate greatly reduced at stresses of 500 psi. and above. Higher silver contents produced undesirable results on the life of the samples and on the creep rate. However, best results were obtained with 0.017% silver additions when 0.061% copper was also present. Cast and rolled lead samples, when annelaed, appear to possess the same stress-rupture properties as extruded lead specimens. The effect of temperature on the creep rate and time to failure was observed.

United States 1948

A METALLURGICAL INVESTIGATION OF A CONTOUR FORGED DISC OF EME ALLOY, E. E. Reynolds, J. W. Freeman and A. E. White, National Advisory Committee for Aeronautics, Techl Note No. 1534, Nov. 30 pps.

Properties of EME alloy (Fe base, 19 Cr, 12 Ni, 3 W, 1 Cb) in the form of contour-forged discs for the rotors of gas turbines were studied at room temperature and 1200°F. Results are compared with data from other laboratories.

United States 1948

A METALLURGICAL INVESTIGATION OF TWO TURBOSUPERCHARGER DISCS OF 19-9DL ALLOY, E. E. Reynolds, J. W. Freeman, and A. E. White, National Advisory Committee for Aeronautics, Tech. Note No. 1535, Nov. 25 pps.

Results of tests to determine properties at room temperature and at 1200°F of this material in forging of the sise used in service. Both discs were given hot cold working treatments at 1300 to 1350° F but one was solution-treated and the other was left in the as-forged condition.

United States 1948

HIGH TEMPERATURE BOLTING MATERIALS, Ernest L. Robinson, American Society for Testing Materials, preprint no. 168, 22 pps.

Performance data on a series of materials suitable for use at various temperatures from room to 1500°F/

Dalton
Cast iron

United States 1948

PLASTIC FLOW IN CAST IRON AT ROOM AND ELEVATED TEMPERATURES, WITH SPECIAL REFERENCE TO RELIEF OF STRESS, C. R. Tottle; Foundry Trade Jour. V. 85, Nov. pp. 445-463.

The effect of strain rate and of intermittent aging and stressing on the ductility of cast iron bars at room and at elevated temperatures. Aging under stress is equivalent to stress relief, and it enables elastic stresses to become plastic.

Data on high-Si cast irons

United States 1948

HIGH-SILICON CAST IRONS RESIST HIGH TEMPERATURES, W. H. White, and A. R. Elsea, Foundry v. 76, Nov. p. 68-69, 230.

Investigation was undertaken to verify the claims made for elevated-temperature applications of high-Si cast irons, to develop a technique for their economical production and to improve their characteristics for specific purposes.

United States 1948

STABILITY OF STEELS AT ELEVATED TEMPERATURES, A. B. Wilder and J. O. Light, Welding Journal, v. 27, Dec. p. 607s-609s, Amer. Soc. for Metals, Preprint, No. 36, 24 pps; Trans. Amer. Soc. for Metals, v. 41, 1949, p. 141-163.

The stability of over 100 different types of steel at 900, 1050, and 1200°F, is being evaluated over a period of 11 years. Welded samples are included. Results obtained from an examination of 20 of these steels for evidence of structural changes, oxidation characteristics, and impact properties after exposure for 10,000 hrs. The influence of Zr, Cb and Ti on graphitization in Mo steels without Cr.

Stellite alloys

United States 1948

Haynes Stellite Co. Haynes Alloys for High Temperature Service.

United States 1948

EQUIP.

CREEP MEASUREMENT WITH WIRE GAUGES; Electrical Eng. V. 67, No. 11, p. 1049.

The use of wire resistance strain gages for the measurement of creep results in better data being obtained.

EQUIP

United States 1948

TEST TURBINES NEAR 100,000 RMP, Aviation Week, v. 49, Oct. p. 21.

Steel pits built to study effects on blades of high speed and temperatures up to 1750°F.

United States 1948 EQUIP.

NEW CREEP TESTING MACHINES, Joseph Marine, Automotive Industries, v. 98, May 15, p. 46-47, 78.

In the past, most creep tests have been made on specimens subjected to simple static tensile stresses. Recently, several static-tension; static-torsion; static-bending; fluctuating-tension; and fluctuating, torsion-tension, creep-testing machines were developed at The Penn. State College.

United States 1948

STRAIN-GAGE FOR TESTING SHEET METAL AT HIGH TEMPERATURE, Glen Gaurnieri and James Miller; Metal Progress, V. 54, No. 5, Nov. pp. 692-694.

A description of an extensometer and instrumental set up which utilizes eight strain gages, so mounted as to cancel out numerous variables and record a single equated value at any instant. The use of such apparatus in the tension, creep, and stress-rupture testing of high alloy material in sheet form at high temperatures is described.

United States 1948

EQUIP.

METHODS OF TESTING CREEP RESISTANT ALLOYS, Wilfred Francis Coxon, Materials and Methods, v. 28, Dec. p. 76-78.

Recent developments in treating and testing creep resistant alloys.

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APPENDIX I

(Cont'd)

England 1948 THEORY EQUIP.

THE CREEP OF METALS, E. N. da C. Andrade, "Report of a Conference on Strength of Solids", The Physical Society, p. 20-26.

Fundamental mechanisms of creep. Apparatus for determination of creep at homogeneous shear. Three methods for maintaining constant stress on specimens under axial tension during testing. 15 ref.

England 1948

CREEP OF METALS, Metal Progress 54: 552, Oct. E. Orowan;

Abstract of "The Creep of Metals" by Orowan. Journal of the West of Scotland, Iron and Steel Institute, V. 54, 1946-47. p. 45.

England 1948 THEORY

DEFORMATION OF CRYSTALS BY THE MOTION OF SINGLE IONS, F. R. N. Nabarro: Physical Society: Rep. Conf. Strength of Solids, PP. 75-90.

On the basis that homogeneous stresses exert no force on vacant lattice sites or on interstitial ions, previous estimates of deformation rates based on the migration of lattice defects under stress are rejected. Surface forces modify the concentration of defects assumed under conditions of thermodynamic equilibrium, and the diffusion of surface imperfections through the lattice as a consequence of the resulting concentration gradient influences the creep rate in such a way as to make it dependent on the specimen size. Because thermal agitation prevents the presence of a limiting total strain independent of the stress, micro-creep in tin cannot be explained on the basis of mosaic-structure theory, though several other phenomena are explainable on that basis. The order of magnitude of non-uniform stresses is calculated, and the creep mechanism resulting from such stress conditions is discussed. The effect of neutron bombardment on creep is described, in relation to the motion and ejection of interstitial ions, and of the consequent creation of vacant lattice sites.

England 1948 THEORY

DISLOCATION THEORY AND TRANSIENT CREEP, N. F. Mott and F. R. N. Nabarro, "Report of a Conferne on Strength of Solids", The Physical Society, p. 1-19.

The theory of dislocations, and application to the theory of transient creep, in the sense in which the term is used by Andrade (1911, 1914, 1932) and by Orowan (1947). 20 ref.

England 1948 THEORY

R. King, R. W. Cahn and B. Chalmers; Nature London 161, p. 682.

Creep by grain boundary movement in the bicrystals.

England 1948 Theory

Data on Pb and a Pb alloy

PRESSURE AND CREEP TESTS AT CONSTANT HOPP STRESS ON LEAD AND ALLOY "E" PIPES, A. Latin; Jour. Inst. of Metals, V. 74, No. 5, Jan. pp. 259-289.

Lead pipe was tested at constant hoop stress by adjusting the internal pressure, in order to determine the Andrade creep constants beta and k. In the case of alloy "E", the extension to fracture was very small at low ~~xxxxxxxx~~ creep rates when compared to that at high creep rates; in the case of pure creep rates when compared to that at high creep rated; in the case of pure lead, the extension to fracture was not affected greatly by the creep rate.

As the applied stress diminishes, the k (slow flow) constant decreases greatly in both materials, while the beta (rapid flow) constant does not change greatly; the flow therefore becomes increasingly beta (rapid) flow as the applied stress is reduced, and increasingly k (slow) flow as the applied stress is increased.

England 1948 THEORY

A METHOD OF FITTING THE ANDRADE CREEP EQUATION TO EXPERIMENTAL RESULTS, A. J. Kennedy, Proc. of the Phys. Soc., v. 61 Dec. 1, p. 510-515.

A method bywhich the constants in the above formula for the flow of metals under constant stress can be rapidly deduced from experimental results by direct reading from a system employing sliding templates of calculated shape. The general equation to which the method is applicable is derived.

England 1948 THEORY

A. H. Cottrell, Report of Conference on Strength of Solids, p. 30 Phys. Soc. London.

Explanation of microcreep on the basis of atomic clouds about the dislocation.

England 1948 THEORY

CREEP OF METALS AND RECRYSTALLIZATION, E. N. Da Andrade, Nature, V. 162, Sept. P. 410.

Pure polycrystalline lead (99199%) which is stable at atmospheric temperature recrystallizes under stress. The crystals increasing in size from about .05 mm. up to about.3 mm. linear dimensions.

A figure which shows length against time for a range of stress (371-985 GM wt/mm^2) is given. The form of those curves differs markedly from that obtained with normal metals. For the recrystallizing lead there is a stage of accelerated creep during the first 10 minutes which is followed by a final creep at an approximately constant rate. It is clear that recrystallisation during creep has a fundamental effect on the form of creep curves.

England 1948

Bardgett, W. E.; J. Iron and Steel Inst. 160, p. 143.

Data on Turbine wheels

Englad 1948

SOME INTERNAL STRESSES IN TURBINE ROTORS, M. C. Caplan, L. B. Jolley, and J. Reeman, Inst. of Metals: Symposium on Internal Stresses in Metals and Alloys, pp. 139-152.

Internal stresses were not found to cause any permanent set in turbine wheels. However, depending on the temperature, shafts may take a permanent set; this depends upon the extent to which internal stresses have been relieved as a result of the high temperature present in turbines. Calculations for the deflection of shafts are included.

England 1948

THE CREEP OF GLASS AT HIGH TEMPERATURES, Ch. Crussard; Sheet Metal, Indus. V. 25, Dec. pp. 2471-2474.

The similarity between the creep curves of glass and of metals is emphasized.

England 1948

Data on Mo, Cr-Mo, + Mo-Va steels

THE CREEP PROPERTIES OF MOLYBDENUM, CHROMIUM MOLYBDENUM, AND MOLYBDENUM VANADIUM STEELS, J. Glen; Jour. Iron and Steel Inst., V. 158, Jan. pp. 37-80.

Creep tests at various temperatures and stresses were conducted on 0.5% Mo, 0.8% Cr-0.5% Mo, 0.5% Mo-0.25% Va steels, and the effect of C, Si, Mn, and Al were determined. Heat-treatments of various types were made.

Rupture tests of up to 58,000 hrs. duration were carried out; the mode of failure was analyzed. The stress-temperature relations for 0.1% and 0.2% deformation in 100,000 hrs. were estimated for Mo-Va steel as a result of extensive long-time creep tests. This steel was found to have creep and rupture properties superior to the other alloys tested.

England 1948

CARBON STEELS: ABNORMAL CREEP RESULTING FROM ALUMINUM ADDITIONS, J. Glen, Iron and Steel, v. 21. May p. 218-221.

Five-day creep tests were conducted on low-carbon steels containing 0.4 to 1.5% Mn, 0.01 to 0.15% Si, and up to 0.11% Mo, and with varying amounts of Al up to 3 lb. per ton. Mn, Si, and Mo reduce the creep rate and help to counteract the abnormal creep resulting from Al additions.

England
~~France~~ 1948

Data on Pb

INFLUENCE OF VARIOUS FACTORS ON THE CREEP OF LEAD, J. N. Greenwood and H. J. Cole, Metallurgia, V. 37, No. 222, April, pp. 285-289.

Long time creep tests on 99.991% pure lead were carried out, and the results were compared to the values predicted on the basis of short time creep. The temperature effect and the influence of a superposed vibratory stress were investigated at various stress levels. The stabilisation of the crystal structure as a result of a 120°C, 24 hour anneal was found to affect the creep rate considerably. Tests were carried out at stresses of 50 psi to 300 psi for one to nine years, with a resulting maximum creep rate of 2.3% per annum. A marked increase in the creep rate was noted at a stress referred to as the creep yield stress; the effect of the temperature on this "critical" stress was observed.

Ni-Cr alloy

England 1948

W. T. Griffiths; Proc. Roy. Aero. Soc. 52, p. 1

Creep curves for an Ni-Cr alloys; of Mond Ni Company

ENGLAND
~~France~~ 1948

Data on stainless steel tubes

HIGH CREEP STRENGTH AUSTENITIC STEEL TUBES, G. T. Harris and W. H. Bailey; Metallurgia, V. 38, No. 226, Aug. pp. 189-192.

The creep and tensile properties of stainless steel tubes used in heat exchangers are discussed in relation to metal processing.

Data on Steels

England 1948

HEAT RESISTING STEELS, L. F. Keeley, Machinery Lloyd (Overseas Edition), v. 20, April 10, p. 68-71.

Composition; scaling and creep; applications.

Data on C-Mo steels

England 1948

A COMPARISON OF SOME CARBON MOLYBDENUM STEELS ON THE BASIS OF VARIOUS CREEP LIMITS, A. E. Johnson and E. H. Tapsell, Proc. Inst. Mech. Eng., V. 159, No. 40, pp. 165-172.

Creep data on six carbon-molybdenum steels are analyzed.

England 1948 THEORY EQUIP

PRESSURE AND CREEP TESTS AT CONSTANT HOOP STRESS ON LEAD AND ALLOY "E" PIPES, A. Latin, Jnl of the Inst. of Metals, v. 74, Jan, p. 259-289.

A method of testing lead and lead-alloy pipes at constant hoop stress, necessitating pressure adjustments. From the results, the Andrade creep constants considered to represent two different types of creep flow were determined. Some consideration is given to the nature of creep flow, and a hypothesis is developed to account for the results. Applications to some problems connected with the use of lead sheath for high-voltage pressure cables. 32 ref.

Data on
Al with
0-12% Si

English 1948

HIGH TEMPERATURE TENSILE PROPERTIES OF CAST Al-Si ALLOYS AND THEIR CONSTITUTIONAL SIGNIFICANCE, W. I. Pumphrey and P. H. Jennings; Jour. Inst. of Metals, V. 75, No. 4. Dec. pp. 203-233.

Strength-temperature curves were obtained for ten alloys containing 0-12% Si; the equicohesive temperature was determined for each alloy.

England 1948 THEORY

A THEORY OF TRANSIENT CREEP IN METALS, C. L. Smith; Proc. Physical Society, V. 61, No. 3, pp. 201-206.

Based on the motion of trapped dislocations released by thermal fluctuations, a theory of transient creep is formulated. As creep progresses, higher activation energies are required for the release of further dislocations, all the low energy dislocations having been gradually released. The creep strain e is found to be proportional to the ratio of the absolute temperature T and the time t less that ration times exp(-ct) where c is a constant; that is, $e=kT\,[1-\exp(-ct)]/t$. Results obtained with zinc single crystals, copper, and lead are in agreement with those predicted by the theory.

Data on Ni-Cr alloys

England 1948 Theory

CREEP OF METALS SUBJECTED TO COMPRESSION STRESS, A. H. Sully, G. N. Cole, G. Willoughby, Nature, V. 162, Sept. pp. 411-412.

Creep tests in compression is conducted at a constant load on some typical creep-resistant nickel-chromium alloys. The results compared with which obtained in tensile creep tests are reported as follows:

1. The creep-rate in the secondary stage is approximately the same in both tests.

2. Tertiary creep occurs in compression as well as in tension and its onset in compressive tests occurs at approximately the same time as in time and tensile tests.

3. The main difference between these two in the teritary stage is that in tensile test, creep proceeds at an accelerating rate until fracture, but in compressive tests creep proceeds in a series of accelerating and decelerating rates.

The reason for this is explained by the author as that in compressive creep the fissures in boundaries making large angles to the direction of the applied stress cannot form as readily as in the case of tensile creep, so that creep may proceed by a series of hardening processes, due perhaps to the blocking of dislocations and to recovery processes akin to the onset of recrystallization. These These hardening and recovery processes may be localized in material adjacent to the grain boundaries due to the stress concentrations in their regions brought about by flow in the boundaries.

England 1948

Tapsell and Ridley, R. W.; Proc. Inst. of Mech. Engrs. London, 153, P. 181.

Long term creep data for C-Mo steels.

N. Monic

England 1948

THE NIMONIC SERIES OF ALLOYS - THEIR APPLICATION TO GAS TURBINE DESIGN, Mond Nickel Co., Ltd.

England 1948 EQUIP

A COMBINED CREEP MACHINE AND X-RAY SPECTROMETER, H. J. Tapsell, H. V. Pollard and W. A. Wood, Jnl of Scientific Instruments and of Physics in Industry, v. 25, June p. 198-199.

The machine is sued in the study of the mechanical properties of metals in realtion to X-ray structure, particularly their creep behavior at elevated temperatures. Special features permit X-ray examination at various times during creep under a stress which is kept constant throughout the period of uniform stretching, and while the specimen is oscillating about its axis and the X-ray film oscillating in its own plane.

England 1948

A CONSTANT-STRESS APPARATUS FOR THE SUTDY OF THE CREEP PROPERTIES OF PLASTICS, A. G. Ward and R. R. Marriott, Jour. Scientific Instruments, V. 25, No. 5, pp. 147-151.

A constant stress is maintained with the help of a cam; the load decreases with the reduction in cross-sectional area. The constant-stress extrusion apparatus can be used for elongations of up to 50%.

England 1948 EQUIP

A. H. Sully, G. N. Cole and G. Willoughby; Nature, London 162, p. 111.

Design of a creep testing machine for compression.

England 1948 Equip.

A NEW DEVICE FOR MAINTAINING CONSTANT STRESS IN A ROD UNDERGOING PLASTIC EXTENSION, Andrade, E. N. Da C., Proc. of Phys. Soc. V. 60, March.

Data on 9.7% Cu-Al-alloy

France 1948 THEORY

SUR LA COMPARAISON DU FLUAGE ET DE LA RELAXATION (Comparison of Creep and Relaxation), Pierre Laurent and Michel Eudier, Comptes Rendus, v. 227, July 26, P. 259-261.

A new experimental method, applied at room temperature, for the creep of an Al alloy containing 9.7% Cu. Comparison of results with theoretical ones based on the Bolzmann principle showed satisfactory agreement.

FRANCE
~~England~~ 1948

CREEP AND RELAXATION, Pierre Laurent and Michel Eudier; Revue de Metallurgia, V. 45, No. 10, 1948, pp. 415-418.

The mathematical relationship between creep and relaxation. Of the three variables, load, time, and deformation, the first is kept constant and the relation between the other two is obtained in creep tests; in relaxation experiments, the last variable is kept constant and the relation between the other two is observed.

Experiments with a 9% Cu-aluminum alloy yield curves which correspond to those obtained theoretically only at low temperatures. The discrepancy between the high temperature experimental and theoretical values is presumably due to inadequate evaluation of the temperature effect in the theory.

France 1948

Comptes Rendus. V. 227, July 26, Pp. 259-261, Michel Eudier,

A new experimental method, applied at room temperature, for the creep of an aluminum alloy containing 9.7% Cu. Comparison of results with theoretical ones based on the Bolzmann principle showed satisfactory agreement.

France 1948 Theory

THE CREEP OF GLASS AT HIGH TEMPERATURES, C. Crussard, Sheet Metal Industries, v. 25, Dec. p. 2471-2474; 2484.

Creep curves for glass are compared with those for metals. Creep recovery is less pronounced in the case of metals, while for glasses the deformation is almost irreversible. Since the same form of curve is found for metals, plastics, and glasses, the reason for creep cannot be existence of a particular structure.

France 1948

CONTRIBUTION TO THE STUDY OF LOW ALLOY STEELS WITH TITANIUM ADDITIONS FOR FORGED HEAT RESISTANT STRUCTURAL PARTS, G. Delbart, R. Potaszkin, and A. Kohn, Revue de Metallurgie, v. 45, Oct. p. 374-385.

Four types of low-alloy steels were investigated from the point of view of their heat stability, castability and mechanical properties.

Austenitic
Aust - Ferritic
steels

France 1948

CONTRIBUTION A L'ETUDE DU COMPORTEMENT A CHAUD DES ACIERS AUSTENITIQUES ET AUSTENO-FERRITIQUES DERIVANT DU TYPE 18-8. (Contribution to the Study of the High-Temperature Behavior of Austenitic and Austenitic-Ferritic Steels of the Modified 18-8 Type)., J. Hochmann; Revue de Metallurgie, v. 45, May-June, p. 171-179.

Results of investigation indicate that austenitic-ferritic steels are superior as regards mechanical strength and freedom from sudden failure at elevated temperatures (500 to 600°C). Also recommends use of Ti, Ta, or Cb as alloy additions.

France 1948

CREEP TESTING AND ITS RESULTS AS APPLIED TO THE DESIGN OF GAS TURBINES, W. Siegfrid. Revue de Metallurgie, v. 45, Oct. 1948, p. 361-373.

Different methods of creep testing. Results indicate that the most accurate data are obtained by long-time creep testing of simple and notched specimens.

France 1948

CREEP AND RELAXATION OF DRAWN STEEL WIRES AT ROOM TEMPERATURE, Robert de Strycker; Revue de Metallurgie, V. 45, Oct. pp. 411-414.

Germany 1948

DIE TEMPERATURABHANGIGKEIT DES ELASTIZITATSMODULS REINER METALLE (The Temperature Dependence of the Elasticity Modulus of Pure Metals) Werner Koster, Zeitschrift fur Metallkunde, v. 39, Jan. p. 1-9.

The above was determined for 32 very pure metals from -180°C to the melting point, or up to about 1000°C, by determining the characteristic vibration frequencies of transverse vibrating bars. 31 ref.

Germany 1948

CONTRIBUTION TO THE QUESTION OF THE DEFINITION OF THE CREEP STRENGTH OF LIGHT METAL ALLOYS, Hugo Vosskühler; Z. Metallkunde, V. 39, No. 3, pp. 79-87.

With few exceptions, the creep curves of light metals become parallel to the time axis after about 1000 days. Thus a true value for the creep strength can be obtained. The total elongation at fracture cannot be correlated with the load, as it can increase ordecrease with increasing load. At extensions of about 0.0005%/hr a point of inflection dependent on the temperature and on the material generally occurs. Recommendations as to the duration of short time creep tests are made for various creep rates for aluminum and magnesium alloys.

Data on Mg Alloys

Germany 1948

THE CREEP STRENGTH OF MAGNESIUM ALLOYS, Hugo Vosskühler; Z. Metallkunde, V. 39, No. 7, pp. 193-204.

Generally at low temperatures the creep strength of forging alloys is superior to that of cast alloys, while the reverse is true at high temperatures. Large grain-sizes are best at high temperaturs, and small grain sizes at low temperatures. Alloys prone to recrystallization pssess lower creep properties than those which are not susceptible to recrystallization at the test temperatures. A correlation of the tensile and creep properties was attempted.

~~United States~~ 1948
Canada

MEASURING CREEP WITH STRAIN GAGES, Iron Age, v. 162, Dec. 23, p. 59.

New technique reported by the Canadian Bureau of Mines.

Canada 1948 62012.

HIGH TEMPERATURE CREEP TESTING, H. V. Kinsey, Canadian Metals and Metallurgical Industries, v. 11, June, p. 19-22, 34.

Canadian laboratory facilities for measuring creep of metals at temperatures up to 2100°F.

~~United States~~ 1948 Equip.
Canada

CREEP MEASUREMENT WITH WIRE GAUGES, Electrical Engineering, v. 67, Nov. p. 1049.

Use of SR-4 bonded resistance-wire strain gages instead of the conventional extensometer as reported by the Canadian Bureau of Mines. This method is said to be simple, accurate, and sensitive, and avoids the problem of attaching cumbersome and inconvenient mechanical devises to test specimens.

Switzerland 1948

UEBER DIE DAUERSTANDFESTIGKEIT VON ZINKLEGIERUNGEN, (The Creep Strength of Zinc Alloys), O. H. C. Messner, Schweizer Archiv, v. 14, May ;. 147-156; June p. 182-190.

Short and long-time creep tests are investigated and results are discussed. 107 ref.

Switzerland 1948
~~SWEDEN~~

UEBER DIE DAUERSTANDFESTIGKEIT VON ZINKLEGIERUNGEN, (Creep Resistance of Zinc Alloys) O. H. C. Messner, Schweizer Archiv fur angewandte Wissenschaft und Technik, v. 14, March. p. 86-94; April, p. 118-127.

Creep resistance of zinc is very low, but may be increased by proper treatment. Creep strength varies with composition but is much more influenced by methods of fabrication, such as heat treatment and working. No definite relationship between creep strength and grain size or structure was found; nor between short and long-term test results. The most likely cause of creep seemed to be internal slip in the crystals.

Russia 1948

METHOD OF DETERMINATION OF RESISTANCE OF METALS TO FRACTURE UNDER TENSILE STRESS (In Russian), G. V. Uzhik, Izvestiya Akademii Nauk SSSR, Otdelenie Teknicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR, Section of Tech. Sciences) Oct. p. 1547-1560.

New method permits easy solution of the problem of absolute value of resistance to shear and tear at each moment of deformation. Typical data for two steels comp red with results of other methods of testing. 10 ref.

RUSSIA
~~United States~~ 1948 THEORY

EVALUATION OF THE TOUGHNESS OF THE DISCS OF STEAM TURBINES (In Russian)
V. F. Yachenko, Kotloturbastroenie (Boiler and Turbine Manufacture), Mar. April 1948, p. 19-22

In evaluating the toughness of the disks of steam turbines, the method of double calculation is applied first, using the influence of the "strain" of the rim and connections and strain in the disk; the method of triple calculation introduces the rim coefficient. 19 ref.

Russia 1948 THEORY

BASIC PRINCIPLES FOR DEVELOPMENT OF HEAT RESISTANT ALLOYS (In Russian) K. A. Osipov, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), v. 60, June 21, p. 1535-1538.

A new method for prediction of the heat resistance of alloys. Data obtained from curves of density of the electronic states and characteristic of each component give clues for such predictions.

Russia 1948 Theory

FACTORS RESPONSIBLE FOR HEAT STABILITY OF HETEROGENEOUS METALLIC ALLOYS, (In Russian) K. A. Osipov, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser. v. 62, Oct. 1, p. 493-495.

The above mentioned were investigated for a series of ternary and quarternary alloys. Besides melting points of the components, the main factors involved are structure and composition of the intermediate phase, and its dependence on temperature and residual stresses.

Russia 1948 THEORY

THE ROLE OF "DISLOCATION" IN THE PROCESS OF CREEP, (In Russian), I. A. Oding, Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR, Section of Technical Sciences) Dec. p. 1795-1802.

Analyzes all possible mechanisms for strengthening and weakening of metals during creep on the basis fo the theory of dislocation. Application of this theory is said to resolve certain controversies concerning the mechanism of the creep process. Describes an additional mechanism of ~~wuk~~ weaking caused by "dislocation" of the strength of metals.

Russia 1948 THEORY

RELAXATION AND CREEP OF METALS CONSIDERING NONUNIFORM DISTRIBUTION OF STRESS, (In Russian), I. A. Oding, Izvestiya Akademii Nauk SSSR, Otdelenie Technicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR, Section of Technical Sciences), Oct. p. 1561-1575.

Investigation assumed that plastic deformation prodeeds by means of diffusion plasticity in the initial sections of the curves of creep and relaxation. On the basis of the diffusion equation, formulas are proposed for initial sections of relaxation and creep cruves, corresponding well with experimental data. 10 ref.

Russia 1948 Theory

ANALYSIS OF SOME CHARACTERISTICS OF THE STRENGTH OF METALS AT HIGH TEMPERATURES, I. A. Oding; Zavod. Lab. (in Russian), V. 14, No. 11, pp. 1365-1377.

A mathematical analysis of the creep and relaxation of metals at high temperature.

Russia 1948 THEORY

DIFFERENT MECHANISMS OF PLASTICITY IN METALLIC ALLOYS (In Russian), A. A. Bochvar, Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR Section of Technical Sciences, May 1948 p. 649-653.

A new approach for the explanation of the mechanism of plasticity of alloys at high temperatures, emphasizing the predominant influence of the character of the interaction of the existing phases of the heterogeneous system.

Russian 1948

INFLUENCE OF ALLOYING ELEMENTS ON THE THERMAL STABILITY OF CHROMIUM NICKEL AUSTENITE (In Russian), A. M. Borzdika, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser. v. 63, Nov. 21, p. 265-267.

The influences of W. Mo, Ti, and Cb on the heat resistance of Cr-Ni steels. The marked difference in atomic diameters of the above elements and of Fe, Cr, and Ni is the main cause of the increase in creep strength of the alloy and, hence, its higher heat resistance.

Dictum
4.2% Si-
Iron

Russia 1948

ELONGATION OF POLYCRYSTALLINE SILICON IRON (4.2% SI) IN THE TEMPERATURE RANGE FROM -195°C to + 800°C. (In Russian), G. N. Kolesnikov, E. S. Yakovleva, and M. V. Yakutovich, Zhurnal Tekhnicheskoi Fiziki (Journal of Technical Physics) v. 18, Nov. p. 1449-1455.

Diagrams of elongation of the above may be classified in two different groups: "low temperature" and "high temperature". Dependence of resistance to deformation, uniform elongation, and sum of elongation and "quasi" uniform elongation on temperature.

Russian 1948

DETERMINATION OF THE TEMPERATURE COEFFICIENT OF THE MODULUS OF ELASTICITY OF SHEET MATERIAL IN BENDING, A. N. Malinkovich and I. M. Roitman; Zavod. Lab. (In Russian), V. 14, No. 7, pp. 839-842.

Determination of the modulus of elasticity of steel and elinvar sheets as thin as 0.4 mm in the temperature range -50° to +100°C.

Data on Fe-Cr, Fe-Ni, Co-Ni, Mn-Ni alloys

Russia 1948 THEORY

RELATIONSHIP BETWEEN MELTING POINTS AND RESISTANCE TO HIGH TEMPERATURES OF ALLOYS, (In Russian), K. A. Osipov. Kodlady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), v. 61, July 1, p. 71-74.

Attempts to establish relationship for a series of binary alloys (Fe-Cr, Fe-Ni, Co-Ni and Mn-Ni). The method of investigation.

Russia 1948 EQUIP.

CREEP TEST MACHINE FOR LIGHT ALLOYS (In Russian) I. L. Portnoi and A. V. Rudnev. Zavodskaya Laboratoriya (Factory Laboratory), v. 14, Aug. p. 985-990.

For long and short-time creep tests at temperatures from 350 to 400°C. This machine is characterized by its simplicity, compactness, and ease of production in industrial shops. Details of construction and examples of tests performed, with corresponding diagrams.

Russia 1948 EQUIP.

COMPARATIVE TESTS ON CREEP OF A RING SPECIMEN IN BENDING AND OF A CYLINDRICAL SPECIMEN IN TENSION, (In Russian), I. A. Oding and S. I. Matveyev, Zavodskaya Laboratoriya (Factory Laboratory), v. 14, May p. 595-607.

A special type of ring specimen for the creep test. Shape and dimensions are indicated. Test apparatus, including electrical circuit and a comparison of the data obtained from such specimens with that from the usual type of specimens.

Russia 1948 EQUIP

SMALL SIZE CREEP TEST MACHINE, (In Russian), M. L. Berhshtein, Zavodskaya Laboratoriya (Factory Laboratory), v. 14, June, p. 760-761.

New apparatus: 22" x 20" x 18", and its characteristics.

Dolu on

United States 1949 Theory Equip.

DYNAMIC CREEP AND RUPTURE PROPERTIES OF TEMPERATURE-RESISTANT MATERIALS UNDER TENSILE FATIGUE STRESS, B. J. Lazan; Proc. ASTM, V. 49, pp. 757-787.

The limitations of static testing and the importance of dynamic creep and rupture properties in designing for high-temperature service are discussed. Newly developed dynamic testing machines and measuring equipment for determining creep and rupture properties are described. Data on several temperature-resistant materials are presented within mean-stress alternating-stress coordinates to show the influence of dynamic stress on creep and time to rupture. The relationships between testing temperature and dynamic stress and their influence on creep and rupture are shown. The increased creep and rupture resistance during some of the dynamic tests is discussed in terms of possible metallurgical changes caused by cyclic stress. Data presented show the greatly decreased ductility caused by the superposition of cyclic stress on tensile preload.

United States 1949

CREEP OF METALS, J. D. Lubahn, American Society for Metals, "Cold Working of Metals", p. 223-247.

Factors that may affect the shape of a strain-time curve. Suggests that strain-time relationships based upon fundamental characteristics of deformation should apply over a wide range of conditions. Limited to creep during which recovery and other transformations do not occur. 30 ref.

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Deformation Polystyrene

United States 1949 THEORY

CREEP-TIME RELATIONS FOR POLYSTYRENE UNDER TENSION, BENDING, AND TORSION, Joseph Marin and George Cuff; Proc. ASTM V. 49, pp. 1158-1180.

The influence of the magnitude of the stress and time upon the creep deformations was determined for each of the foregoing types of stress. Contorl tests and stress-strain or load-deformation relations were obtained for simple tension, compression, simple bending, pure bending, and torsion. Creep values for bending and torsion derived from creep-tension data agreed with the measured values.

United States 1949
(Russia)

STRENGTH OF ALLOYS AT HIGH TEMPERATURE, K. A. Osipov. Metal Progress, V. 56, Aug. p. 262, 266, 268, 270, 272.

Based on three papers in Doklady Akademii Nauk SSSR.

United States 1949 Theory

BENDING OF BEAMS WITH CREEP, E. P. Popov; Jour. Applied Physics., V. 20, No. 3 March, pp. 251-256,

A method of calculating stresses and deflections for beams whose material creeps is presented in this paper. Complete tension creep test data at constant temperature are used to define creep characteristics of the material. They by using Bernoulli's hypothesis of plane sections and the techniques developed earlier for interpretation of the relaxation creep tests, a method of beam analysis is shown. Stresses and deflections may be calculated for any desired time interval. This includes the time prior to the occurrence of the steady state creep. The latter aspect appears to have been ignored by other.s

United States 1949 Theory

MECHANISM OF STEADY-STATE CREEP IN METALS, B. G. Rightmire; Physical Review, V. 75, No. 10, p.1627.

The Dushman relation for steady state creep namely that the stress varies linearly with the logarithm of the strain rate, leads to the deduction that about 1000 atoms are present in a flow unit. But since the activation energy values lead to flow units of the order of 10 atoms, it is necessary to postulate that the flow units are dislocations which move in segments rather than as a whole; one atom at a time jumps and the others follow one by one. On this basis, and with the use of absolute reaction rate theory, it is possible to compute the number of atoms in a dislocation, and the velocity and concentration of dislocations. Calculations were made for aluminum, silver, and platinum. In the case of aluminum, it appears that there that there are few fast moving dislocations; this may explain the presence of slip bands.

United States 1949 TACOR-1

CORRELATION OF TENSION CREEP TESTS WITH RELAXATION TESTS, Irving Roberts, Jnl. of Applied Mechanics, v.16, Trans. of the Amer. Society of Mechanical Engineers, v. 71, June , p. 208.

Analytical solutions to the bolt relaxation problem, based upon empirical creep-data equations, may be obtained by direct substitution rather than by differentiation and integration, as was done by Soderberg, Popov, and Housner.

United States 1949 (MCC02-4

APPLICATION OF REACTION RATE PRINCIPLES TO SOME MECHANICAL PROPERTIES OF MATERIALS, Edward Saibel, Trans. of the NewYork Academy of Sciences, Ser. 2, V. 11, Feb. p. 135-147.

How the above has been accomplished in several cases. Such phenomena as creep, viscosity, and fatigue can only be fully explained by application of physical principles analogous to these of chemical reaction. Discussion of theory of the rate of propagation of fracture cracks in metals. 18 ref.

Data on Polystyrene

United States 1949 Theory

CREEP AND DAMPING PROPERTIES OF POLYSTYRENE, J. A. sauer, J. Marin and C. C. Hsiao; Jour. Applied Physics. V. 20, No. 6, June, pp. 507-517.

The anelastic behavior of polystyrene has been studied by means of creep tests under long-time load application andby means of damping capacity tests under rapidly varying repeated loading. Tensile creep data taken at various stress amplitudes reveal that the log of the creep rate (at 1000 hours) varies linearly with the log of the stress amplitude. A similar type of variation is obtained when damping capacity or energy absorbed per cycle is plotted against stress amplitude. From these two sets of data, the creep rate is found to be proportional to the square of the damping capacity. It would thus appear possible, for polystyrene at least, to predict 1000-hour creep rates from short-time measurements of absorbed energy under dynamic loading conditions.

The data obtained from the creeping and damping tests, together with additional data from short-time tension and compression tests, seem to be consistent with an internal structure in which the linear polymer chains and groups of chains are in ordered or partially extended positions, but in which, in the absence of stress, no preference is shown for any particular direction. Under the action of stress, particularily if the stress is maintained for a lohg period of time, a tendency exists for the ordered regions to orient in the direction of the applied stress. The so-called "crazing" condition which has been observed to occur in the creep specimens is probably a manifestation of this orientation. X-ray evidence appears to support this point of view.

United States 1949

FUNDAMENTALS OF CREEP, Howard Scott, Metal Progress, v. 55, Man p. 343-344.

Takes issue with conclusion in Feb. 1948 issue that there is no correlation between creep and tensile strength. Defends use of complex "practical" alloys, which, although containing at least eight or nine metallic components, behave in a regular and predictable manner.

United States 1949

WANTED: BETTER CRITERIA FOR TURBINE ALLOYS. W. O. Sweeny, Metal Progress, v. 55, Mar. p. 315-318.

Limitations of present mechanical test methods for use in high-temperature alloys and fields where further investigation would be likely to be profitable. Further work on fundamental metallurgy as well as on test methods is considered desirable.

United States 1949

TESTING MATERIALS AT HIGH TEMPERATURE, F. G. Tatnall, Mechanical Engineering, v. 71, Nov. p. 906-910.

Short-time stress-strain, stress-rupture, creep, relaxation, and fatigue tests.

United States 1949 THEORY

EFFECT OF PRESTRAINING TEMPERATURES ON THE RECOVERY OF COLD WORKED ALUMINUM, T. E. Tietz, R. A. Anderson, and J. E. Dorn, Jnl of Metals (Trans.) v. 1, Dec. Trans. of the Amer. Inst. of Mining and Metallurgical Engineers, v. 185, p. 921-926.

Mechanical properties of cold worked metals depend not only on instantaneous values of strain, strain rate and temperature, but on the entire past history of temperature and strain rate during prestraining. Observations appear to suggest that lower temperatures of prestraining induse formation of smaller or otherwise more readily activated dislocations.

United States 1949 THEORY

MECHANISM OF CREEP IN METALS, G. R. Wilms, Jnl. of the Amer. Soc. of Naval Engineers, v. 61, Nov. p. 892-907.

Jnl. of the Institute of Metals, v. 75, Apr. p. 693-706.

How the mechanism by which a metal deforms at elevated temperatures differs from that at normal temperature, and how the difference depends on the rate of deformation.

1949 THEORY EQUIP
United States

REPORT OF JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS. American Society for Testing Materials, Proc. v. 49, 1949, p. 241-255.

Includes brief appendices as follows: "Effect of Variables on the Creep Resistance of Steels" (H. C. Cross); "Stability of Steels as Affected by Temperature" (J. J. Kanter); and "High-Temperature and Low-Temperature Testing Equipment in the United States" (results of a questionnaire).

United States 1949

SELECTION OF HEAT RESISTANT STEELS I., J. B. Henry, Product Engineering, v. 20, July p. 113-118.

Factors influencing steels the high-temperature service include strength, ductility, and fatigue resistance at operating temperatures, as well as resistance to oxidation and corrosion caused by other media in contact wtih the metal. (To be continued).

SELECTION OF HEAT RESISTANT STEELS, II. V. 20, Aug. p. 113-115.

Effects of extended exposure on mechanical properties; embrittlement, intergranular precipitation; thermal stresses; and relative costs.

United States 1949

CERAMIC-METAL ALLOYS HAS THERMAL SHOCK RESISTANCE NEEDED FOR TURBINE BLADES, Product Engineering, v. 20, July, p. 150-151

Investigation of an alloy containing 80% TiC and 20% Co conducted at the NACA Lewis Laboratory to determ ne resistance to thermal shock, short-time tensile strength at elevated temperatures, and performance characteristics under simulated service test conditions.

United States 1949

STRENGTH OF METAL AIRCRAFT ELEMENTS, Munitions Board Aircraft Committee, ANC-5a, May, 109 pgs.

Mechanical properties of alloy, Carbon, Stainless, Bearing, heat, resistant and corrosion resistant steels, as well as Al and Mg alloys. 52 ref.

United States 1949 Group Data on 12 high-temp alloys

COMPARISON OF HIGH TEMPERATURE ALLOYS TESTED AS BLADES IN A TYPE B TURBO-SUPER-CHARGER, W. C. Stewart and H. C. Ellinghausen; Trans. ASME, V. 71, Aug. pp. 613-620.

The need for test information concerning the high temperature strength characteristics and stability of gas turbine alloys beyond that provided by stress-rupture, creep, and gas erosion tests is discussed. The practicability of testing a number of alloys in the form of blades in an air-craft, turbo-super-charger operated as a gas turbine is pointed out. By this procedure, blades of 12 different alloys are simultaneously tested, since the rotor contains 142 blades. Tests on both wrought and cast alloy blades were made at eight temperatures, ranging from 1200-1500°F, and for as long as 1000 hrs. Measurements of the extension of the blades are presented graphically.

Data on Cu with .05-.2% Ag

United States 1949

THE COMPARATIVE CREEP PROPERTIES OF SEVERAL TYPES OF COMMERCIAL COPPERS, A. D. Schwope, K. F. Smith, and L. R. Jackson; Jour. of Metals, V. 1, No. 7, July pp. 409-416. (AIME TP No. 2605E).

The effect of cold work on the creep characteristics of tough-pitch and of OFHC coppers, unalloyed and silver bearing, has been determined for temperatures from 200° to 572°F. The most important results are:

1. Cold work increases the creep strength of copper; however, the benefit from cold work is lost at temperatures where recrystallization is rapid. These temperatures vary with the amount of cold work and the type of copper.

2. The addition of silver to either tough-pitch or OFHC copper raises the temperature at which rapid recrystallization occurs; the effect is approximately the same on both types of copper.

3. While additions of silver effectively lower the creep rate of both tough-pitch and OFHC copper as cold worked, the silver-bearing OFHC copper has a marked lower creep rate than comparable tough-pitch copper.

United States 1949

DEOXIDATION, REFINING PROCESSES FOUND TO AFFECT CREEP-TO-RUPTURE TESTS, G. V. Smith and E. J. Dulis, Steel, v. 126, Aug. 22, p. 99.

United States 1949

EFFECT OF MANUFACTURING PRACTICE ON CREEP AND CREEP RUPTURE STRENGTH OF LOW CARBON STEEL, G. V. Smith and E. J. Dulis; Proc. ASTM, V. 49, pp. 584-601.

Comparative creep to rupture tests at 850°F on twelve heats of low-carbon steel made by different melting and deoxidation practices show a rather wide range in results dependent chiefly upon the deoxidation practice employed. The extimated stress for rupture in 10,000 hr. ranged from 12,000 to 20,000 psi, and the observed stress to produce a minimum creep rate of 0.1% per hr. ranged from 19,000 to 32,000 ppi. Silicon deoxidized steels were stronger than aluminum deoxidized steels. All specimens "necked in" and showed severely elongated grains at the fracture. Notch impact values and hardness determined on specimens subjected to creep tests but before rupture indicated that no important deterioration occurred in ordinary mechanical properties.

United States 1949

Equip

Data on high temp alloys 19-9-DL 16-25-6

HOT SPIN TESTS OF BALDED JET ENGINE ROTORS, H. B. Saldin and P. G. DeHuff, Jr; Trans. ASME, V. 71, Aug. pp. 605-612.

The creep-rupture and ductility characteristics of materials are of greatest importance to the designer of high-temperature rotating parts. Four-bladed discs were tested in a facility that was designed to spin the rotors in as near engine operating conditions as possible. The tests were made in accordance with a predetermined schedule of temperature gradient, temperature and speed. It wasfound that the characteristics type of failure appears to have a direct relationship to the magnitude of the ductility for a given material. Of the four discs reported, the standard 19-9-DL showed the best combination of a strength and ductility, although the Timken 16-25-6 material as processed was slightly stronger than the standrad 19-9-DL.

Dalaon
24S-T3
Al-all.

United States 1949

ELEVATED-TEMPERATURE COMPRESSIVE STRESS-STRAIN DATA FOR 24S-T3 ALUMINUM ALLOY SHEET AND COMPARISONS WITH EXTRUDED 75S-T6 ALUMINUM ALLOY, William M. Roberts and George J. Heimerl; NACA Tech. Note. No. 1837, Mar. 11pp.

Results are presented of compressive stress-strain tests of 24S-T3 aluminum alloy sheet at stabilized elevated temperatures up to 700°F, exposure times of 1/2 to 2 hours, and strain rates of 0.002 to 0.006 per minute. Some general comparisons with extruded 75S-T6 aluminum alloy are included.

United States 1949

THE EFFECT OF STRAIN TEMPERATURE HISTORY ON THE FLOW AND FRACTURE CHARACTERISTICS OF AN ANNEALED STEEL, E. J. Ripling and G. Sachs, Jnl. of Metals, v. 1, sec. 3 Feb. p. 78-90.

Results of experimental work on a low-carbon, 2.75% Si steel. Conclusions regarding the effect of straining a ferritic material at one temperature on fracture and flow characteristics at some other temperature. 11 ref.

"heat-resistant alloys"

United States 1949

HIGH TEMPERATURE CHARACTERISTICS OF HEAT RESISTANT ALLOYS, Norman S. Mott, Product Engineering, v. 20, Sept. p. 163.

Data sheet.

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Data on Inconel alloys, SAE 1020, + S-816

United States 1949

SHORT-TIME HIGH-TEMPERATURE DEFORMATION CHARACTERISTICS OF SEVERAL SHEET ALLOYS, James Miller and Glen Guarnieri, Trans. ASM. V. 41, pp. 167-193.

From short time constant rate tensile tests at elevated temperatures true stress-true strain characteristics have been determined for five different types of alloys over a range of temperatures and strain rates. The alloys used were: SAE 1020, regular Inconel, Inconel X, annealed S-816, and cold rolled S-816. An attempt was made to use the data as a means of learning more about the mechanics of deformation at elevated temperatures through determination of the activation energies involved. The increase in such energy values with decrease in stress, as was found for all materials, was attributed to the effect of elastic distortion on the crystal lattice. A simplified mechanism of deformation is described using these characteristics, and the relationship of the flow process to metallic diffusion is pointed out.

United States 1949

THE EFFECTS OF TEMPERATURE AND MATERIAL STRUCTURE ON THE FRACTURE PROPERTIES OF MEDIUM-CARBON STEEL, Julius Miklowitz, American Society for Testing Materials, Proc. v. 49 p 602-617.

Effects of variations in temperature of testing, size of grain, and type of pearlite in the structures of a Si-killed and Si-Al-killed steel on ductility and strength were determined. Apparatus and test results. Micrographs show structures resulting from various thermal treatments.

United States 1949

THE CREEP STRENGTH AT 200°C OF SOME MAGNESIUM ALLOYS CONTAINING CERIUM, G. A. Mellor and R. W. Ridley, Jnl of the Inst. of Metals, v. 75, Apr. p. 679-692.

A number of the alloys were tested as cast, as rolled, and as rolled and heat treated. Little advantage was gained by increasing the Ce content beyond 1½-2%. Rolled alloys are markedly inferior to cast alloys unless they are solution treated. Slight age hardening took place in alloys containing 0.5-6% Ce.

Dalton
Ni-Cu alloy
+
Cu

United States 1949

INFLUENCE OF TEMPERATURE ON THE STRESS-STRAIN ENERGY RELATIONSHIP FOR COPPER AND NICKEL-COPPER ALLOY, D. J. McAdam, Jr; Jour. of Metals, V. 1. No. 10, Oct. pp. 727-740. (AIME TP No. 2703E).

Results derived from tension tests of unnotched cylindrical specimens of monel and oxygen-free Cu at strain rates a little slower than those ordinarily used in tension tests and at temperatures of -188 to +165°C. 23 references.

United States 1949

Equip.

Data on 14S-T Al alloy

EFFECT OF PULSATING LOADS ON THE CREEP CHARACTERISTICS OF ALUMINUM ALLOY 14S-T, M. J. Manjoine; Proc. ASTM, V. 49, pp. 788-803.

This paper describes a creep-rupture testing machine in which oscillating and steady loads may be applied. This machine was developed to check the influence of adding a small oscillating stress to the steady stress in a creep-rupture test. The results of a series of tests at 400°F of 14S-T aluminum alloy specimens under an oscillating stress of 10% of the mean stress are reported. The effect of this oscillating stress depends on the magnitude of the mean stress. A possible explanation of the tests results is discussed.

United States 1949

Dalcan
Al alloys

SIMULTANEOUS AGING AND DEFORMATION IN METALS, J. D. Lubahn; Jour. of Metals, V. 1, No. 10, Oct. pp. 702-708, (AIME TP No. 2697E).

Constant strain rate tensile tests, constant load creep tests, and variable strain rate tensile tests were carried out on an age hardenable aluminum alloy to determine the effects of simultaneous aging and deformation. The following unusual deformation characteristics were observed: 1. discontinuous yielding in a tensile test; 2. periodic sudden extensions in a constant load creep test; 3. failure ever to undergo gradual extension at a constant load; 4. unexpected transients following a sudden rate change; 5. an inverse rate effect where an increase in flow stress beyond the transient is required to maintain a smaller strain rate.

Mg-Rare earth alloys

United States 1949

THE PROPERTIES OF SAND CAST MAGNESIUM-RARE EARTH ALLOYS, Thomas E. Leontis; Jour. of Metals, V. 1, No. 12, Dec. pp. 968-983, AIME TP. No. 2726E.

All the rare earth metals investigated enhance the strength, hardness, and creep resistance of magnesium at room and elevated temperatures. The various magnesium-rare earth metals may be rated in the following order of decreasing tensile properties at room and elevated temperatures and creep resistance at 400 and 500°F: 1. magnesium-didymium. 2. magnesium cerium-free Mischmetal. 3. magnesium-praseodymium-lanthanum. 4. magnesium-Mischmetal. 5. magnesium-cerium. 6. magnesium-lanthanum. At 400°F the properties of magnesium-didymium alloys are 20% to 50% higher than those of magnesium-Mischmetal. The relative effect of each rare earth metal on the creep resistance of magnesium at 600°F depends upon the composition level and, to a certain extent, upon the grain size.

United States 1949 THEORY

ANALYSIS OF THE TEMPERATURE COEFFICIENT OF SHEAR MODULUS OF ALUMINUM, T8ing Sui Ke; Physical Review, V. 76, No. 4, Aug. p. 579.

The mxplicity and implicit contributions to the temperature coefficient of the shear modulus of an aluminum crystal were investigated. It was found that the explicityly temperature-dependent term contributed more than one-third of the total temperature coefficient. This indicates that the shear modulus cannot be regarded as a function of only the volume, even in an approximate way.

United States 1949

THE PLASTIC, CREEP, AND RELAXATION PROPERTIES OF METALS, A. E. Johnson; Aircraft Eng., V. 21, No. 239, pp. 2-8, 13.

The high temperature behaviors of a low carbon steel and an aluminum alloy under complex stresses were investigated. The creep strain appeared to follow the Mises-Hencky shear-strain energy criterion of yielding. The creep rate vs. stress relation in its early and intermediate stages was in fair agreement with the Saint Venant-Mises equation which assumes the material to be isotropic.

United States 1949

Data on
Ingot Fe

INFLUENCE OF STRAIN RATE AND TEMPERATURE ON THE CREEP OF COLD DRAWN INGOT IRON, William D. Jenkins and Thomas G. Digges; Jour. Research Bureau Stds. V. 43, No. 2, Aug. pp. 117-131. (RP 2013).

A study was made of the effects of variations in both strain rate and temperature on the creep characteristics ib tension of cold-drawn ingot iron. The third stage of creep began without necking or without the presence of cracks of microscopic dimensions, but considerable necking occurred in all specimens tested to fracture. The resistance to creep in the second stage and the resistance to fracture increased as the test temperature was decreased. The stress required to initiate fracture also increased as the strain rate increased. The general trend was for the ductility at fracture to increase with an increase in the strain rate. The plastic extension at fracture decreased with an increase in test temperature. The plastic extension at the beginning of the third stage was less than about 1%, except in specimens tested at relatively high strain rates or at a low temperature. The fractures were predominantly trnascrystalline in the tension tests with the different strain rates used at and below 600°F, and intercrystalline at test temperatures of 700° and 800°F.

United States 1949

TITANIUM . . . ITS PROSPECTS. L . ITS PROPERTIES, R. I. Jaffee and I. E. Campbell, Iron Age, v. 164, July 28, p. 48-51.

Also considers metallurgical concepts in alloying and in applying the material to high-temperature service.

United States 1949

INITIAL INVESTIGATION OF CARBIDE TYPE CEREAMAL OF 80% TITANIUM CARBIDE PLUS 20% COBALT FOR USE AS GAS TURBINE BLADE MATERIAL, Charles A. H ffman, G. Mervin Ault, and James J. Gangler, National Advisory Committee for Aeronautics, Tech. Note. No. 1836, Mar. 49 pps.

Performance in a quasi-service gas-turbine unit. Alloy blades were used in the same unit for comparison. Elevated-temperature, short-time tensile, and thermal-shock investigations were conducted on the ceramal material. Results were encouraging. 10 ref.

United States 1949

75S-T6
Al alloy

DETERMINATION OF PLATE COMPRESSIVE STRENGTHS AT ELEVATED TEMPERATURES, George J. Heimerl and William M. Roberts. National Advisory Comm. for Aeronautics, Tech. Note. No. 1806, Feb. 20 pps.

Local-instability tests of extruded 75S-T6 Al-Alloy H-sections at stabilized elevated temperatures up to 600°F. Results show that methods available for calculating critical compressive stress at room temperature can be used at elevated temperatures if the applicable compressive stress-strain curve is given.

United States 1949

Data on
Ni-base
alloys with
Al, Mo, + Cr

NICKEL-BASE ALLOYS FOR HIGH TEMPERATURE APPLICATIONS, A. C. Guy; Trans. ASM, V. 41, pp. 125-140.

Information is given on a new series of cast nickel-base high temperature materials containing Al, Mo, and Cr as the principal alloying elements. Rupture test data at 1500°F show that a number of the alloys in the series have higher rupture strengths than the best of the cobalt-base materials now in use. These alloys also have excellent oxidation and moderate fatigue strength. Although, compared to cobalt-base materials, these alloys have low elongation and impact resistance, it is probable that they are suitable for many industrial applications.

Data on Polyethylene

United States 1949

THE CREEP CHARACTERISTICS OF COMPRESSION MOLDED POLYETHYLENE, G. R. Gohn, J. D. Cummings, and W. C. Ellis; Proc. ASTM V. 49, 1949, pp. 1139-1157.

Data are presented on the creep properties at various stress levels ranging from 50 to 1000 psi.

Station
7
Ceramic
Materials

United States 1949

PHYSICAL PROPERTIES AT ELEVATED TEMPERATURE OF SEVEN HOT-PRESSED CERAMICS, James J. Gangler, Chester F. Robards, and James E. McNutt; NACA Tech. Note. No. 1911, July, 33 pp.

Presents investigation to determine elevated temperature short time tensile strength, relative resistance to thermal shock, coefficient of thermal expansion and density of seven ceramics fabricated by hot-pressing. Ceramics are boron carbide, titanium carbide, zirconium carbide, 85% silicon carbide plus 15% boron carbide, magnesium oxide, zircon, and stabilized zirconia. Titanium carbide was the most promising of the seven ceramics for possible gas-trubine application because of high tensile strength at elevated temperatures and its superior resistance to thermal shock.

United States 1949

ON THE EXTRAPOLATION OF SHORT TIME STRESS RUPTURE DATA, Nicholas J. Grant and Albert G. Bucklin, American Society for Metals, Preprint No. 18, 33 pps.

A large number of stress-rupture tests was made on alloy S-590 at 1200-1900°F and on S-816 at 1200-1500°F. Rupture times varied from 3 sec. to 26,000 hr! The validity of straight lines in the log-log and semi-log plots of stress vs. rupture time and of stress vs. minimum creep rate is examined on the basis of these tests. Suggests method for predicting long-time performance or performance at other temperatures based on extrapolation of instability points clearly shown in log-log plots of rupture data. Data are analyzed on the basis of the chemical rate processtheory. A value of "True elongation" is determined from stress-rupture tests, which appears to establish ductility changes as a function of increasing time or decreasing strain rate at a given temperature.

Data on
N-155
alloy

United States 1949

FUNDAMENTAL EFFECTS OF AGING ON CREEP PROPERTIES OF SOLUTION-TREATED LOW-CARBON N-155 ALLOY, D. N. Frey, J. W. Freeman, and A. E. White, NACA Tech. Note, No. 1940, Aug. 73 pp.

An experimental procedure is described which is believed suitable for establishing the fundamental mechanisms by which processing, heat treatment, and chemical composition control the properties of alloys at high temperature. The method relates microstructures and x-ray diffraction characteristics after various prior treatments to creep and rupture test properties. Results are given for application of the method to solution-treated and aged low-carbon N-155 alloy and correlation with short-time creep and rupture characteristics at 1200°F.

United States 1949

Data on
low-C
N-155
alloy

THE INFLUENCE OF CONDITIONS OF HEAT TREATMENT AND HOT-COLD WORK ON THE PROPERTIES OF LOW-CARBON N-155 ALLOY AT ROOM TEMPERATURE AND 1200°F, J. W. Freeman, E. E. Reynolds, D. N. Frey, and A. E. White; Proc. ASTM V. 49, pp. 618-645.

From tension and rupture tests the following data were obtained: yield strength range at 0.02% offset at room temperature, 30,000 to 134,000 psi; rupture strength range at 1200°F, 40,000 to 60,000 psi at 100 hrs.; 35,000 to 56,000 psi at 1000 hrs. to an estimated 600,000 hrs., depending on the treatment of the specimen. These ranges, resulting from variations in thermal and mechanical treatment, are greater than those which result from variations in composition.

Data on
low-C
N-155
alloy

United States 1949

A STUDY OF EFFECTS OF HEAT TREATMENT AND HOT COLD WORK ON PROPERTIES OF LOW CARBON N-155 ALLOY, J. W. Freeman, E. E. Reynolds, D. N. Frey, and A. E. White, NACA Tch. Note, No. 1867, May 61 pp.

Physical properties at room temperature and rupture test characteristics at 1200°F were used as a criterion to evaluate the effects of systematic variations of solution treatments, aging treatments, and hot-cold work on the properties of bar stock from one heat of low carbon N-155 alloy. On the basis of the yield strength for 0.02% offset at room temperature, and rupture properties at 1200°F, standard type treatments that are best for the alloy could be set up.

Vulcan
Ti

United States 1949

SOME NEW DATA ON THE PROPERTIES OF WROUGHT TITANIUM, F. B. Fuller, Metal Progress, V. 56, No. 3, Sept. pp. 348-350.

Tension and compression data obtained at various temperatures, and including yield strength, elongation, and modulus of elasticity values, are supplied for (1) annealed and (2) cold rolled titanium sheet and bar stock rolled (a) longitudinally and (b) transversely. Hardness, impact, and fatigue data are also furnished.

United States 1949

Data on S-590 alloy

NACA AND OFFICE OF NAVAL RESEARCH METALLURGICAL INVESTIGATION OF TWO LARGE FORGED DISCS OF S-590 ALLOY, J. W. Freeman and Howard C. Cross, NACA Tech. Note, No. 1760, Feb. 63 pp.

Properties of large forged discs of S-590 alloy at room temperature, 1200°, 1350° and 1500°F were studied to determine the level of properties obtainable in forgings required for rotor discs of gas turbines. One disc was aged after forging; the other, solution treated and aged. A limited amount of testin was done on the solution treated disc prior to aging. Results are given for tensile, impact, rupture, time deformation, creep, and structural stability tests.

United States 1949 Theory

Dater
Com. Al alloys

CREEP AND STRESS-RUPTURE INVESTIGATIONS ON SOME ALUMINUM ALLOY SHEET METALS, J. E. Dorn and T. E. tietz; Proc. ASTM, V. 49, pp. 815-833.

Increased interest in the elevated temperature properties of aluminum alloys prompted investigations on the creep and stress-rupture characteristics of 3S-H12, 3S-H18, 52S-H32, 52S-H38, 61S-T6 and 24S-T3 (ASTM Designation M1-H12, M1-H18, Gr1-H38, GS21-T6 and CG21-T3 respectively). From 90°F to 400°F the above sequence of alloys was found to be the order of increasing resistance to creep and stress-rupture. Cold rolling appears to have a beneficial effect on the creep resistance and the time to rupture.

The data for 3S-H12 and also 3S-H18 were analyzed in terms of Hollomon's theory of creep, but the theory did not correlate well with the experimental facts.

United States 1949

ELEVATED-TEMPERATURE PROPERTIES OF SEVERAL TITANIUM CARBIDE BASE CERAMALS, George C. Deutsch, Andrew J. Repke, and William G. Lidman; NACA Tech. Note. No. 1915, July, 47 pp.

The elevated-temperature properties of titanium carbide base ceremals in the temperature range of 1600° to 2400°F were investigated to obtain information on the bonding mechanisms. The compositions studied were titanium carbide plus 5, 10, 20, and 30% by weight each of tungsten, molybdenum, and cobalt. The properties investigated were density, tensile strength, modulus-of-rupture strength, coefficient of linear expansion, and oxide-coating composition and structure. On a strength-to-weight ratio basis, ceremals appear promising as gas turbine blade materials in the temperature range of 1600° to 2400°F.

Datum
Inconel X

United States 1949

OFFICE OF NAVAL RESEARCH AND NACA METALLURGICAL INVESTIGATION OF A LARGE FORGED SIC OF INCONEL X ALLOY, Howard C. Cross; NACA Tech. Note. No. 1770, April 31 pp.

Properties of a large forged disc of Inconel--X alloy were determined for the solution-treated and aged conditions at room temperature, 1200°, 1350°, and 1500°F. Included are results of tensile, impact, rupture, time-deformation, creep and structural stability tests

United States 1949

Data on S-816 alloy

OFFICE OF NAVAL RESEARCH AND NACA METALLURGICAL INVESTIGATION OF A LARGE FORGED DISC OF S-816 ALLOY, Howard Cross and J. W. Freeman; NACA Tech. Note, No. 1765, Fe. 45 pp.

Properties of large discs of S-816 alloy have been determined for both the as-forged and aged condition and the heat-treated and aged condition by means of stress-rupture and creep tests for time periods up to about 2000 hours at room temperature, 1200°, 1350° and 1500°F. Short-time tensile test, impact test, and time-deformation characteristics are included.

Data on low-alloy, 5% Cr, + 18-8 steels with - Bo + Ti

United States 1949

A NEW LOW ALLOY STEEL FOR HIGH TEMPERATURE USE, George F. Comstock; Metal Progress, V. 56, No. 1, July, pp. 67-71.

When boron and titanium are added to a soft steel, it quenches out to B-85, and this hardness is even increased by long stay at 1100°F. No trace of graphitization was found after 10,000 hr. at that temperature. Stress-rupture tests indicate 1000 hr. life at 1000°F and 50,000 psi. Boron and titanium (or columbium) additions are also found to improve the stress-rupture properties of 5% chromium steel and 18-8.

Data on Pressure Vessels

United States 1949

PRIMARY CREEP IN THE DESIGN OF INTERNAL PRESSURE VESSELS, L. F. Coffin, P. Shepler and G. Cherniak; Jour. Applied Mech., V. 16, Sept. pp. 229-241.

Thick-walled cylinders are tested under hydrostatic pressure at high temperatures. The permanent strains resulting from primary creep are compared to those due to secondary crepp. It is concluded that in the design of pressure vessels for short life, consideration of elastic conditions and primary creep is essential, while for long life, secondary creep analysis is sufficient.

United States 1949

SOME OBSERVATIONS ON THE RECOVERY OF COLD WORKED ALUMINUM, T. V. Cherian, P. Pietrokowsky, and J. E. Dorn, Jnl of Metals. Trans. v. 1, Dec. Trans. of the Amer. Inst. of Mining and Metallurgical Engineers, v. 185, p. 948-956.

Effects of recovery on various physical and mechanical properties have been extensively studied. Here effects on the true stress-strain curve were investigated. Effects of different temperatures and prestrains on 2S-0 aluminum. Type types of recovery designated as "meta" and "ortho" were distinguished, indicating that the work hardened state is characterized by at least two essentially distinct types of imperfections.

United States 1949

HIGH TEMPERATURE PROPERTIES OF TITANIUM ALLOY CASTINGS, P. H. Brace and W. J. Hurford, Metal Progress, v. 55, Mar. p. 362-363.

Results of creep-rupture and tensile tests on alloys containing 30-50% or more of high-melting materials. Alloys comparing favorably with conventional high-temperature materials and considerably lighter were obtained. Best yield strengths were obtained with Ti-Cr base (20-40% Cr) alloys containing Mo and W in 4-1 atomic ratio.

United States 1949

THE APPLICABILITY OF CERAMICS AND CEREMALS AS TURBINE-BLADE MATERIALS FOR THE NEWER AIRCRAFT POWER PLANTS, A. R. bobrowsky; Trans. ASME, V. 71, Aug. pp. 621-629.

Ceramics and ceremal materials have been investigated for use as turbine-blade materials for aircraft gas turbines. Tensile, flexure, thermal-shock, and oxidation data for these materials at temperatures up to 2400°F are presented. It was found that several ceramics and ceremals possess excellent tensile properties at high temperatures, and that carbide base materials possess good thermal shock resistance and operate cooler than most high-temperature alloys or oxide-base materials. Although ceramics and ceremals have operated as blades in gas turbines at temperatures abowe those in service use with alloy blades, speeds were lower and lives were shorter than those of alloy blades.

Data on Ti

United States 1949

CREEP OF TITANIUM AT ROOM TEMPERATURE, Heinrich Adenstedt; Metal Progress V. 56, No. 5, Nov. pp. 658-660.

Tensile and creep data are presented for annealed titanium sheet and cold rolled titanium strip at room temperature. The minimum creep rates of titanium are compared to those of other structural metals. It is seen that the annealed titanium sheet showed the highest tendency for creep. In cold rolled titanium strip, a load equal to 80% of the yield strength produces a creep rate of 0.0001% per 1 hr., while loads of only 50 to 60% of the yield strength give the same creep rate in the annealed material. An unfavorable property of pure titanium is revealed; dangerous secondary creep is in evidence even with loadings which are below the yield strength. However, alloying and heat-treatment may improve creep properties.

Data on
Pb and Pb
with Cu & Ag

United States 1949
(Done in England)

THE INFLUENCE OF VIBRATION ON THE CREEP OF LEAD, J. Neill Greenwood; Proc. ASTM, V. 49, pp. 834-856.

Creep tests on two industrial (very pure) leads and two lead alloys, one containing 0.027% Ag and theother 0.07% Cu have been made under conditions whereby a gentle 50 cycles per second vibration was superposed on direct tensile stress. The stresses were between 100 and 350 psi. It is shown that vibration increases the rate of creep and also accelerates the recrystallization under stress. During recrystallization the creep rate increases considerably. Without vibration the industrial lead will recrystallize after an extension of 4 to 5% whereas, wi h the vibration superposed, this will occur after 2.5% extension. The grain size increases considerably during this process. It is shown that under certain conditions the creep rate of lead can be increased by the presence of silver. The effect of copper is affected by the degree of dispersion; the finer is the dispersion, the more the c reep rate is lowered. Both alloying elements reduce the susceptibility of lead to recrystallize under stress, at least up to 15% extension. Annealing lead at 120°C for 24 hr. stabilized the crystal grains, reduces the creep rate under given conditions, and reduces the susceptibility to recrystallization under stress.

EQUIP.

United States 1949

STEELS FOR ELEVATED TEMPERATURES SERVICE, U. S. Steel Corp. Pittsburgh, (book), 87 pgs.

General principles of behavior. Test methods and laboratory techniques. Tabular and graphical data on mechanical properties of 21 steels covering a wide variety of chemical compositions. Testing facilities of U. S. Steel Corp.

United States 1949

AIR CONDITIONING CUTS OUT CREEP TEST COMPENSATIONS, Steel, v. 125, July 4, p. 95.

Creep-testing machines and testing procedure in an air-conditioned room held at constant temperature at the research laboratory of National Tube Co.

United States 1949

Equip

A SIMPLE CONSTANT-STRESS CREEP TEST, J. C. Fisher and R. P. Carreker; Jour. of Metals, V. 1, No. 2, Feb. p. 178 (AIME Tech. Note No. 10E).

The use of a "V" shaped specimen supported at its ends and loaded at the vertex of the angle is advocated for constant stress creep tests. The angle at the vertex of the "V" should be approximately 90°. This method for obtaining constant stress is especially suited to the testing of small wires, but may easily be extended to rods of any diameter through the use of a suitable grip which serves as the vertex joining two identical rods forming the legs of the "V";

United States 1949

EQUIP

MECHANICAL TESTING AT HIGH TEMPERATURES, H. E. Gresham, Metal Industry, v. 75, Dec. 2, p. 471-474.

Methods and equipment.

United States 1949 EQUIP.

MECHANICAL TESTING AT HIGH TEMPERATURES, H. E. Gresham, Metal Industry, v. 75, Dec. 2, p. 471-474.

Methods and equipment.

England 1949 Theory

MECHANISM OF CREEP IN METALS, G. R. Wilms and W. A. Wood; Jour. Inst. of Metals, V. 75, No. 8, April, pp. 693-706.

The difference between the high temperature deformation mechanism and that at room temperature depends on the strain rate. At room temperature the mechanism consists of slip and of the breakdown of the grains to crystallites (so called mosaic blocks); at higher temperatures and lower strain rates, this mechanism is overshadowed by the dissociation of the grains into fairly coarse units, flow being due to the motion of these units within each grain. These units are called cells so as to differentiate them from crystallites. The influence of strain rate and of temperature on the cells was determined; the motion of the cells takes place without reference to specific slip planes. The x-ray technique used is very sensitive: a 10° difference in the orientation of the cells would show up as 180° on the x-ray film; therefore the actual difference in orientation of the cells (which is less than 1°) is easily measurable. Most of the deformation takes place near the cell boundaries, and since the cells are relatively large, little strain-hardening takes place, and we have quasi-viscous creep. When crystallite formation predominates, we have transient creep. In actual proactice we have a combination of the two mechanisms, one or the other predominating depending on the temperature and strain rate conditions.

England 1949 THEORY

THE PLASTIC BEHAVIOUR OF SOLIDS, Andrew McCance, Jnl of the Iron and Steel Institute, v. 163, Nov. p. 241-249.

Fourth Hadfield Memorial Lecture discusses the theory of plastic extension, indicating disagreement with the von-Mises-Hencky view that the plastic stage is merely a degenerated elastic stage whose behavior can be formulated by an extension of elasticity theory. Equations derived from the author's theory were tested by work on steel, Cu, Al, Pb and non-metallics. Includes variations in plastic behavior; brittleness and plasticity; behavior of rubber; and creep under constant load. 19 ref.

ENGLAND 1949 Theory

THERMAL STRESSES IN TURBINE BLADES' M. J. Lighthill and F. J. Bradshaw; Philos. Mag. V. 40, No. 306, July, pp. 770-780.

A theory of thermal stress in turbine blades is developed on the assumption that at each point of the blade planform the stresses are approximately those that would be set up in a free infinite slab of uniform thickness equal to the blade thickness at that point. Consequence of the theory are that in cooling the maximum stress occurs at all times near the position of maximum thickness, but that in heating the largest stresses are initially near an edge, though as time goes on their position moves toward that of maximum thickness, and their magnitude increases. Maximum stress is inversely proportional to thermal conductivity for the lower heat transfer rates, but is less sensitive to it at higher rates.

 DM/A

~~[illegible]~~
England 1949

THE CREEP OF METALS AND ALLOYS, E. G. Stanford; Temple Press, London, 1949, 162 pp. (book).

England 1949

METALLIC CREEP AND CREEP RESISTANT ALLOYS, A. H. Sully; Interscience Publishers, Inc., New York 290 pp. (book).

The measurement of metallic creep is described, and the characteristics of creep curves are discussed. The characteristics of deformation of metals and the physical theory of creep are both outlined in some detail. An analysis of the metallurgical factors as they affect the creep properties is presented. The creep of both ferrous and non-ferrous alloys is treated in detail, and the development of creep resistant materials is traced.

England 1949 THEORY

THE MECHANISM OF DEFORMATION IN METALS, WITH SPECIAL REFERENCE TO CREEP, W. A. Wood and W. A. Rachinger, Jnl of the Inst. of Metals, v. 76, Nov. p. 237-253.

A study was made of changes in crystalline structure produced at various temperatures when a metal was subjected to the slow rate of strain typical of creep process and also to the relatively rapid rate associated with ordinary mechanical testing. Measurements were also made at the same time of strength under various conditions of deformation. The object was to investigate the relation of deformation by creep to that by slip. Results show that the grains develop a sub-structure of a size determined by temperature and rate of strain. The mechanism of deformation changes from slip to creep as the elements of the sub-structure exceed a certain size.

Dotuon
Pb

England 1949 Theory

THE EFFECT OF INSTANTANEOUS PRE-STRAIN ON THE CHARACTER OF CREEP IN LEAD POLYCRYSTALS, A. J. Kennedy; Proc. Physical Soc., V. 62, No. 356B, Aug. pp. 501-508.

The extension-against-time curves of lead wires that have been subjected to rapid strain just before the experiment may be expressed by the Andrade creep equation $l=l_o(1+Bt^{1/3})\exp(kt)$, using the same constants as those which satisfy the creep of the metal under the same constant stress, but with the t value associated with β replaced by $(t+t_o)$, where t_o is a constant for a given experiment, its value increasing with increasing prestrain. While for prestrains less than 10% the value of k is unchanged by the prestrain, for greater prestrains the k-flow is also modified and appears to approach more nearly to a linear variation with stress.

England 1949 THEORY

CREEP AND RELAXATION OF METALS AT HIGH TEMPERATURES, Engineering, v. 168, Sept. p. 237-239. Condensed from "The Relaxation of a Chrome-Molybdenum Bolt Steel at Elevated Temperatures", and the "Relaxation of Two Low-Carbon Steels at Elevated Temperatures", both by A. E. Johnson, British Electrical and Allied Industries Research Association. Reports J/T144 and 145.

Analyses effects of some of the factors which might influence creep at high temperatures. Validity of the analysis was checked against the results of relaxation and normal creep tests carried out at National Physical Laboratory, at temperatures up to 525°C for periods up to nearly two years. Results indicate that within the range of conditions applied, normal creep properties should not be used to predict relaxation characteristics; and that the time and strain hardening theories of creep considered are not entirely satisfactory.

England 1949

SELECTING STEELS WITH HIGH CREEP STRENGTH, Steel Processing, V. 35, Mar. p. 143-144 (reprinted from Mechanical World, London).

A general discussion.

Data on Zn with Co, Ni, or Mn

England 1949

THE EFFECT OF ALLOY ADDITIONS ON THE CREEP STRENGTH OF ZINC, F. Pawlek; Sheet Metal Industries, V. 26, No. 262, pp. 303-308, 318.

The effect of cobalt, nickel, iron and manganese on the creep strength of zinc.

Data on Mg with 0-2% Ce

England 1949

THE CREEP STRENGTH AT 200°C OF SOME MAGNESIUM ALLOYS CONTAINING CERIUM, G. A. Mellor and R. W. Ridley; Jour. Inst. of Metals, V. 75, No. 8, April, pp. 679-692.

Creep tests on cast, rolled, and rolled and heat-treated 0-2% cerium containing magnesium alloys (with or without manganese) under a stress of 2 tons/sq.in. at 200°C reveal that rolled alloys are weaker than cast alloys, unless they are solution treated. Additional creep resistance is observed in alloys containing about 0.5% cerium; this is due to age hardening. Optimum conditions are obtained with 1.5% cerium, and cerium in excess of 1.5% or in amounts less than 0.5% does not contribute substantially to the properties. These alloys have low 0.1% proof stress of about 5.7 tons/sq.in. at room temperature, and an ultimate strength of about 12.4 tons/sq.in.

England 1949

TEMPERATURE AND METALS. NOTES ON THE EFFECT OF TEMPERATURE ON CERTAIN PROPERTIES OF METALS WITH PARTICULAR REFERENCE TO CREEP. (Continued) F. C. Lea, Edgar Allen News, v. 28, Aug. p. 354-356.

Title only.

TEMPERATURE AND METALS, (Concluded) Edgar Allen News. v. 28, Sept. 1949, p. 380-381.

Noted on the effect of temperature on certain properties of metals with particular reference to creep.

England 1949

BEHAVIOR OF CAST STEEL AT ELEVATED TEMPERATURES, A. E. Johnson, Engineer, v. 188, July 29, 1949, p. 126-128; Aug. 5, 1949, p. 138-141; Aug. 12, 1949, p. 165-168; Aug. 19, 1949, p. 189-191; From British Electrical and Allied Industries Research Association Report J/T 137. "The Behaviour of a Nominally Isotropic 0.17% C Cast Steel Under Combined Stress Systems at Elevated Temperatures".

About 80 tests consisting of pure tensile, pure torsion and complex stress-creep tests (the latter under various combinations of simple tensile and torsion stresses) at 350, 450 and 550°C. Extensive mathematical analysis.

Data on
Al alloys

England 1949

THE CREEP OF A NOMINALLY ISOTROPIC ALUMINUM ALLOY UNDER COMBINED STRESS SYSTEMS AT ELEVATED TEMPERATURES, A. E. Johnson; Metallurgia, V. 40, No. 237, July, pp. 125-139.

The purpose of the present investigation was to examine the nature of the creep properties of an initially isotropic cast aluminum alloy at temperatures of 150° and 200°C., and under general stress systems. Some forty to fifty tests consisting of pure tensile, pure torsion, and complex stress creep tests (combinations of simple tension and torsion) have been performed. The results have been anlyzed, and equations for the stress-strain relatipns for the aluminum alloy over the temperature range concerned have been derived..

England 1949

THE RELAXATION TEST IN TERMS OF CREEP AND CREEP RECOVERY, E. A. Johnson, Metallurgia, v. 39, Apr. p. 291-297.

An effort to ascertain the relative importance of creep recovery as a link between the relaxation test and normal creep tests. Relaxation tests from relatively high and relatively low initial total strains were made on a 0.17%-C steel at 445°C., and on a Cr-Mo steel at 485°C. Estimates of creep recovery during the relaxation test were made by completely unloading the specimen at intervals during the test. Adjustment of measured creep rates was made to allow for effects of negative recovery strain; and modified relaxation-creep rates were compared with rates computed from auxiliary creep tests.

Data on
Pb with
Ca

England, 1949

THE INFLUENCE OF CALCIUM ON THE CREEP CHARACTERISTICS OF LEAD, J. Neill Greenwood and J. H. Cole; Metallurgia, V. 39, No. 233, March. pp. 241-245.

The addition of small amounts of calcium to lead results in a marked reduction in the creep rate, and although there are indications that aging occurs after rolling, calcium lead still shows to advantage compared with pure and copper lead. The age hardening which occurs during the 10 hours after quenching has apparently little effect on the long-term creep results. There are certain technical difficulties with calcium lead, but these need cause little or no trouble, provided they are anticipated and the conditions adapted accordingly.

Data on Pb with Cu + Ag

England 1949

THE INFLUENCE OF VARIOUS FACTORS ON THE CREEP OF LEAD ALLOYS, J. Neill Greenwood and H. J. Cole; Metallurgia, V. 39, No. 231, Jan. pp. 121-126.

Results of some creep tests on a number of lead alloys are recorded. The experiments, which have been in progress more than ten years, are concerned with the influence of steady stress at 20°C and at 50°C on alloys containing respectively copper and silver, and also the influence of steady stress vibration and previous heat-treatment on alloys containing respectively 0.075% copper and 0.03% silver.

Data on Ti

England 1949

THE TENSILE STRENGTH OF TITANIUM AT VARIOUS TEMPERATURES, R. L. Bickerdike and D. A. Sutcliffe; Metallurgia, V. 39, No. 234, April. pp. 303-304.

England 1949

TEMPERATURE AND METALS, F. C. Lea, Edgar Allen News, v. 28, July, p. 325-329.

Effect of temperature on certain properties of metals with particular reference to creep. Creep testing equipment and typical data. (To be continued).

England 1949 EQUIP

PREPARING THIN SPECIMENS FOR CREEP AND TENSILE TESTING, Paul Feltham; Metallurgia, V. 41, No. 241, P. 60.

England 1949 EQUIP

AN AUTOMATIC RECORDING APPARATUS FOR THE STUDY OF FLOW AND RECOVER IN METALS, E. N. C. Andrade, and A. J. Kennedy; Proc. Phys. Soc. V.62, No. 359B, Nov. pp. 669-675.

An apparatus is decribed which records continuously on photographic paper the extension-against-time curve of a metal wire creeping under stress. The length and time scales are recorded on the paper at the same time as the extension, so that deformation of the paper during development and drying does not affect the accuracy of the record, which allows an extension of up to 10 cm. to be read within 0.02 mm. The apparatus also automatically removes and restores, repeatedly if desired, the load at times which can be set before the start of the experiment.

England 1949

CREEP, P. S. Wakefield, Machinery Lloyd (Overseas Edition), v. 21, Sept. 24, p. 68-69, 71-3.

Phenomenon of creep, its testing, and practical applications of creep-test results.

Equip

England 1949

CREEP IN METALS AND METHODS OF CREEP TESTING, M. Randall, Machinery (London), v. 74, June 9, p. 772-773.

Typical creep-rate vs. stress and creep vs. time curves.

England 1949

EQUIP,

COMPRESSION CREEP TESTING, A. H. Sully, Metal Industry, v. 75, Dec. 9, p. 491-492.

New type of apparatus designed for stresses up to 10 tons per sq. in. and temperatures up to at least 1000°C. Typical results.

France 1949 THEORY

INFLUENCE OF STRESS CONCENTRATION, SPEED OF DEFORMATION, AND TEMPERATURE ON THE RUPTURING STRENGTH OF STEELS, A. Guessier and R. Castro. Engineers' Digest v. 10, Oct. 1949, p. 350-354; Dec. 1949, p. 412-414. Translated and condensed.

Previously abstracted from Revue de Metallurgie.

(Mechanical Behavior of Isotropic Rlycrystalline Metals Analogy of Brittleness Factors), Revue de Metallurgie, v. 46, Aug. 1949, ;. 517-536.

Influences of three essential parameters of elastic and plastic deformation (separately or combined) were studied for isotropic metals, especially steels. These parameters are: state of stress, characterized by index of triaxiality, reciprocal of the temperature of deformation, and rate of deformation. They are designated as "brittleness factors". 22 ref.

French 1949

PROPERTIES OF ALUMINUM ALLOYS AT TEMPERATURES CLOSE TO THAT OF THE SOLIDUS (In French), M. W. I. Pumphrey, Fonderie, Nov. p. 1807-1816.

Mechanical properties were investigated for pure Al and Al alloys with Cu, Si, and Fe near the solidus temperature. Tendency toward crack formation at temperatures above the solidus was determined for various concentrations of alloying elements. 12 ref.

France 1949 THEORY

ON THE INFLUENCE OF PLASTIC DEFORMATION ON THE MODULUS OF ELASTICITY, Pierre Laurent and Michel Eudier; Comptes Rendus, V. 228, No. 3, pp. 225-226.

The effect of creep on the modulus of elasticity. Experiments on 9.7% Cu-aluminum alloy reveal that the modulus of elasticity is decreased by creep at room temperature; the modulus drops in value as a function of time. Since the alloy is stable, and since the change in orientation of the grains is negligible (at loads of approximately 12.8 tons per sq.in.), it is concluded that the decrease in the value of the modulus of elasticity is due to the interaction of the forces between the grains as a result of the applied load.

France 1949

CONTRIBUTION A L'ETUDE DE LA RELATION ENTRE LA STRUCTURE MICROGRAPHIQUE ET LA RESISTANCE AU FLUAGE. INFLUENCE DE LA CHARGE. Contribution to the Study of the Relationship Between Microstructure and Creep Strength. Influence of the Applied Load) Georges Delbart and Michel Ravery. Comptes Rendus (France), v. 229, Oct. 17, p. 759-670.

Investigated for 0.6% Cr, 0.6% Mo steel with particular emphasis on the relationship between rate of creep and load applied at a given temperature.

Al-alloy

EQUIP.

France 1949

CREEP OF ALUMINUM ALLOYS, (In French), R. Chenigny and R. Syre, Revue de Metallurgie, v. 46, Oct. p. 682-686.

A study of the fundamental characteristics. Method of investigation and data.

France 1949

FERRITIC STEEL FOR GAS TURBINES, G. Wood and J. R. Rait, Revue de Metallurgie, v. 46, June p. 386-398.

A series of alloy steels was comparatively investigated including some austenitic steels. (To be continued).

Germany 1949

DIE MECHANISCHEN EIGENSCHAFTEN VON TITANLEGIERTEN BLECHEN NACH LUFTABKUHLUNG AUS DER WALZHITZE (The Mechanical Properties of Titanium-Containing Sheets After Air Quenching From Rolling Heat) Peter Bardenheuer and Wilhelm Anton Fischer. Archiv fur das Eisenhuttenwesen, v. 20, Sept. Oct. p. 313-322.

Three test steels (0.4-1.2% Ti and 0.10%C) were melted in the electric-arc furnace; and one steel with 0.6% Ti in the openhearth furnace. They were rolled at different temperatures to 20 and 12 mm. thickness. Mechanical properties were determined at room temperature, 350 and 500°C. Macrostructures and outer appearances of test samples.

[illegible]
cast iron

Germany 1949

HEAT RESISTANT CAST IRON, Gerhard Clas and Karl Houben, Die Neue Giesserei, v. 36 (new ser. v. 2) May p. 131-138.

The main types of thermal stresses as well as the resulting physico-chemical reactions. The thermal behavior of cast irons alloyed with Cr, Al and Si. 12 ref.

Germany 1949

DAUERVERSUCHE AN SCHRAUBENFEDERN (Long-Time Tests on Coil Springs) Max Hempel, Stahl und Eisen, v. 69, Sept. 29, p. 712-713.

Test results on alloy and carbon-steel springs. The tests were made at room temperature and at 250°C.

Cr-Ni-Mo
Cr-Mo, + Cr-V
Steels

Germany 1949

ZUG- UND KERBSCHLAGVERSUCHE AN CHROM-NICKEL -MOLYBDAN, CHROM-MOLYBDAN- und CHROM-VANADIN-STAHLEN IN DER WARME AND KALTE (Tensile and Notch-Impact Tests on Chromium-Nickel-Molybdenum, Chromium-Molybdenum and Chromium-Vanadium Steels at High and Low Temperatures) Anton Pomp and Alfred Krisch Archiv fur das Eisenhuttenwesen, v. 20 Sept.-Oct. p. 323-328.

One hundred forged and annelaed specimens were investigated to determine differences between the recently developed alloys and those made in earlier years. 17 ref.

Rules on steel

Germay 1949

CREEP STRESS EXPERIMENTS ON SEVERAL UNALLOYED BASIC BESSEMER STEELS AND HIGH ALLOY HEAT RESISTANT STEELS AT 500-900°C, Anton Pomp and Alfred Krisch. Archiv fur das Eisenhuttenwesen, v. 20, Mar-Apr. p. 125-134.

The creep-stress resistance of the above steels was determined by several different methods, under nine different conditions, and for periods exceeding 1000 hours. The various methods and the results are critically evaluated. 53 ref.

Germany 1949

THE STRENGTH BEHAVIOR OF LOW ALLOY HEAT RESISTANT STEELS AND THEIR TENDENCY TO BRITTLE FRACTURE, K. Richard, Archiv fur Metallkunde, v. 3, May, p. 157-164.

Critically examines the customary methods of testing fatigue-stressed heat resistant steels. Causes and remedies for brittle fracture as well as their relationship to other properties of steels. The need for long-time testing is stressed. 22 ref.

Cr - Mo Steels

German 1949

TENSILE AND NOTCH IMPACT TESTS ON CHROMIUM-NICKEL-MOLYBDENUM, CHROMIUM-MOLYBDENUM AND CHROMIUM-VANADIUM STEELS AT HIGH AND LOW TEMPERATURES, Anton Pomp and Alfred Krisch, Archiv fur das Eisenhuttenwesen, v. 20, Sept. Oct. p. 323-328.

One hundred forged and annealed specimens were investigated to determine differences between the recently developed alloys and those made in earlier years. 17 ref.

Germany 1949

THE BEHAVIOR OF STEEL AT ELEVATED TEMPERATURES; SURVEY OF THE LITERATURE PUBLISHED IN THE YEARS 1944-47), (Concluded), Anton Pomp. Stahl und Eisen, v. 69, May 12, p. 339-342.

19 ref.

Germany 1949

THE HEAT RESISTANCE OF THE LIGHT METLAS, A. Schimmel, Archiv fur Metallkunde, v. 3, June p. 212-213.

The properties and treatment of heat resistant Al alloys and methods of testing their strength properties at elevated temperatures.

Mg - ... alloys

Germany 1949

SYSTEM OF THE RELATIONSHIPS OF THE HIGH-MELTING HEXAGONAL METALS TO MAGNESIUM; HIGH-TEMPERATURE ALLOYS BASED ON Mg-Th-Zr. (In German). F. Sauerwald, Zeitschrift fur anorganische Chemie, v. 258, May p. 296-306.

The alloyability of Be, Cr, Ti, Zr, Mo, Hf, W. Os, Th, and U with Mg was investigated. It was found that Y, Zr, Os, and Th can be readily combined with Mg. Mg-Th-Zr-Ce alloys are not only highly heat resistant but also have the highest known creep-stress resistance of all Mg-base alloys. 11 ref.

EQUIP

Germany 1949

DETERMINATION OF THE CREEP STRENGTH OF FERROUS AND NONFERROUS METALS, (In German) Alfred Krisch, Archiv fur das Eisenhuttenwesen, v. 20 Nov. Dec. p. 395-399.

Common methods for determining the high-temperature behavior of metals. The flow curve and the process of determining creep in long and short-time experiments. 70 ref.

Russian 1949 THEORY

PLASTIC BENDING, L. A. Shofman and P. I. Lokotosh, Zavodskaya Laboratoriya (Factory Laboratory) v. 15, Nov. p. 1348-1355.

Single calculation formula for determination of bending moment under both cold and hot plastic bending in the region of large deformations. Satisfactory agreement of experimental and calculated values establishes validity of the formula. Possibility of determining yield strength at high temperatures by bending tests.

Russia 1949 THEORY

THEORY OF DIAGRAMS OF ADDITIVE DEFORMATION AND CALCULATION OF TRUE RESISTANCE TO RUPTURE. (In Russian), V. Ya. Shekhter. Zavodskaya Laboratoriya (Factory Laboratory), v. 15, Aug. p. 957-961.

Theoretically analyzes bases of the concept of additive deformation. Curves of additive deformation can be used for determination of true resistance to rupture. Typical determinations for a series of ferrous and nonferrous metals and alloys.

Russia 1949 THEORY

MECHANISM OF PLASTICITY OF HOMOGENEOUS METALLIC ALLOYS AT HIGH TEMPERATURES, (In Russian), K. A. Osipov. Izvestiya Akademii Nauk SSSR (Bulletin of the Academy of Sciences of the USSR). Section of Technical Sciences, Sept. pp 1372-1377.

Theoretical data and experimental investigation of binary and quaternary metallic alloys. A basic mechanism is strengthening the nonuniformity of distrubution of the components, which may lead to formation of a new phase.

Russia 1949 THEORY

ANALYTICAL EXPRESSION OF THE RELATIONSHIP BETWEEN MELTING POINT AND THERMAL STABILITY OF METALLIC ALLOYS, (In Russian) K. A. Osipov. Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser. v. 68, Sept. 1 p. 81-82.

A formula, based on Mott's equation, for the determination of rate of slip. Experimental investigation indicates validity of the formula.

Russia 1949 Theory

SOME GENERAL LAWS OF THE PROCESS OF ELASTIC-PLASTIC DEFORMATION (In Russian) I. I. Bol'denblat, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser., Oct. 21, p. 1005-1008.

Theoretical investigation. Proposes a new generalized formula, which is interpreted for different values of the variables.

C. Steel

Russian 1949 THEORY

INFLUENCE OF RATE OF DEFORMATION ON STRENGTH OF CARBON STEEL AT HIGH TEMPERATURE, (In Russian), M. A. Zaikov, Zhurnal Teknicheskoi Fiziki (Jnl. of Technical Physics), v. 19, June p. 711-721.

Experiments on fracture of steel (0.08-0.15% C) at different rates of deformation and different temperatures 20-1150°C) establish relationship of yield strength and constant of plastic deformation to temperature and rate of deformation. Agreement of rate coefficient with previously determined relationship of yield strength to temperature and chemcial composition of steel is indicated. 30 ref.

alloys

Russia 1949

DIFFERENT EXPLANATIONS OF THE INFLUENCE OF ADDITIONS ON THE HEAT RESISTANCE OF BINDARY COPPER ALLOYS (In Russian) M. V. Zakharov, Doklady Akademii Nauk SSSR, (Reports of the Academy of Sciences of the USSR), new ser. v. 65, Mar. 21, p. 337-339.

Investigation of various binary and quasi-binary Cu-alloy systems indicates that they can be classified into three distinct types: those in which heat resistance decreases rapidly up to 500°C, and then decreases; those in which it continues to increase regularly even above 500°C; and a combination type which may decrease again at higher temperatures on account of diffusion.

Russia 1949

HEAT RESISTANCE OF CERTAIN BINARY COPPER ALLOYS, (In Russian) M. V. Zakharov, Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk (Bulleting of the Academy of Sciences of the USSR, Section of Technical Sciences), Jan. p. 124-130.

The influence of degree of heterogeneity on relative heat resistance of a series of alloys of the Cu-Zn, Cu-Sn, Cu-Al, and Cu-Be systems. Phase diagrams, upon which are superimposed curves of hardness vs. composition at various temperatures.

Russian 1949

STRENGTH OF CARBON STEELS AT HIGH TEMPERATURES, (In Russian), M. A. Zaikov. Zhurnal Teknicheskoi Fiziki (Jnl of Technical Physics), v. 19, June, p. 684-695.

Relationship of yield strength to temperature of annealing and melting point by experiments on fracture of test specimens of carbon steels containing 0.12-1.19% C. Formulas for computation of mechanical constants. Experimental method. Results for structural toolsteels for different temperature regions.

Dataran
Mn

Russia 1949

INFLUENCE OF TEMPERATURE ON MECHANICAL PROPERTIES OF MANGANESE (In Russian) E. M. Savitskii and V. F. Terekhova, Doklady Akademii Nauk SSSR (Reports of the Adademy of Sciences of the USSR) new ser. v. 68, Sept. 1, p. 87-90.

Upon heating of Mn, certain modifications having a simpler structure, characterized by a smaller number of atoms in the unit cell, begin to predominate. This results in increased plasticity.

Russian 1949

CENTRIFUGAL METHOD FOR TESTING METALS AND ALLOYS AT HIGH TEMPERATURES, (In Russian), M. E. Rabinovich, Zavodskaya Laboratoriya (Factory Laboratory) V. 15, Aug. p. 988-993.

Investigation of heat resistance of alloys of the Al-Cu-Mn-Zn system at 300°C. Influence of Zn addition to the ternary system.

Russia 1949

INFLUENCE OF TEMPERATURE ON MECHANICAL PROPERTIES OF MANGANESE, (In Russian), E. M. Savitskii and V. F. Terekhova, Doklady Akademii Nauk SSR (Reports of the Academy of Sciences of the USSR), new ser. v. 68, Sept. 1. p. 87-90.

Upon heating of Mn, certain modifications having a simpler structure, characterized by a smaller number of atoms in the unit cell, begin to predominate. This results in increased plasticity.

Russia 1949 Equip. Solid Solution alloys

CONTRIBUTION TO THE THEORY OF HEAT RESISTANCE OF METALLIC SOLID SOLUTIONS, (In Russian) I. I. Kornilov, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser. v. 67, Aug 21. p. 1037-1040.

Heat stability of solid solutions of 11 different binary, ternary, and quaternary systems of ferrous and nonferrous metals were investigated using a new centrifugal mechanical testing method.

Russia 1949 THEORY

DEFORMABILITY OF COPPER-ZINC ALLOYS (In Russian), S. I. Gubkin and A. B. Simbirskii, Izvestiya Akademii Nauk SSSR (Bulletin of the Academy of Sciences of the USSR), Section of Technical Sciences, Oct. P. 1501-15[illegible].

Influence of composition and temperature on mechanical properties and deformability of alloys containing 0.41% Zn. Diagrams are interpreted in terms of optimum temperatures and deforming forces. Value of a mechanical interpretation of constitution diagrams for more extensive developemtn of the theory of alloys is demonstrated.

Russian 1949

COMPARATIVE CREEP CHARACTERISTICS OF TYPE 14-14 CHROMIUM-NICKEL AND CHROMIUM-MANGANESE STEEL, (In Russian), A. M. Borzdyka, Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk (Bulletin of the Academy of Sciences of the USSR, Section of Technical Sciences), June, p. 900-906.

Investigated on four samples of Type 14-14 steel with 2.5% W, two being Cr-Ni base and two Cr-Mn base. Each pair included a low-carbon and a medium carbon steel. The Cr-Mn austenite was found to have much higher (10-20%) thermal stability than the Cr-Ni. Thermal stability of Cr-Mn steel of the austenite-ferrite type is shown to be directly dependent on relative content of alpha and gamma phases.

Russia 1949

RUSSIAN CHROMIUM-SILICON-COPPER AND CHROMIUM-SILICON-ALUMINUM HEAT-RESISTANT STEELS, M. P. Braun, Circulaire d'Informations Techniques, v. 6, Mar. p. 115-119. Translated and condensed from Stal (Steel) Jan 1948, p. 60-64.

The influence of different alloying elements such as Si, Cu and Al and of heat treatment, microstructure and mechanical characteristics of chromium steels. Chemical compositions of various test specimens and their mechanical properties.

Russia 1949

FRACTURE OF TOUGH MATERIAL IN COMPRESSION BY SHEAR (In Russian), S. I. Bubkin, A. N. Danil'chenko, and V. G. Osipov, Zavodskaya Laboratoriya (Factory Laboratory) v. 15, Sept. p. 1100-1101.

Investigated for steel containing 0.19% C, 0.58% Mn, 0.63% Cr, 0.47% Ni and 0.40% Cu at temperatures between room and 1300°C. It was found that shear fracture may follow two paths: in a plane at an angle of 45° to the direction of the applied force and in a plane parallel to the axis of the applied force at an angle of 45° to the radius.

Russia 1949 Euro.

FURNACE FOR SHORT AND LONG TIME CREEP TESTS AT HIGH TEMPERATURE, (In Russian), A. V. Antonovich. Zavodskaya Laboratoriya (Factory Laboratory), v. 15, May, p. 618-621.

Method of operation. Electrical circuits for temperature regulation and for furnace heating.

EQUIP.

Russia 1949

APPARATUS FOR TESTING MATERIALS UNDER COMPLEX-STRESS CONDITIONS, (In Russian) M. L. Bernshtein, W. M. Onchukov and I. A. Yarov, Zavodskaya Laboratoriya (Factory Laboratory), V 15, Sept. p. 1136-1138.

Machine which permits testing to be done at room and elevated temperatures under complex-stress conditions - bending plus tension.

Equip.

Russia 1949

NEW METHOD OF HIGH-TEMPERATURE MECHANICAL TESTING, (In Russian), A. M. Borzdyka, Zavodskaya Laboratoriya, (Factory Laboratory), v. 15, Jan. p. 70-75.

Methods used for testing at a controlled rate of elongation, for creep testing at 800-1200°C; for creep testing during ~~twisting~~ bending; and for testing by a relaxation method.

Russia 1949 Equip.

CREEP TESTING MACHINE, (In Russian) Yu. S. Gintsburg and N. D. Zaitsev. Zavodskaya Laboratoriya (Factory Laboratory), v. 15, July, p. 878-882.

Newly developed creep-test machine designed for mass screening test s of alloys and for high-temperature tests in creep, continued to rupture. This machine tests alloys to 1100°C. Maximum tensile load is 750 kg. Limits of creep may be determined at deformations of the order of 10% per hour.

Russia 1949 Equip.

MEASUREMENT OF SAGGING DUE TO SMALL LOADS AT THE MOMENT OF STRUCTURAL TRANSFORMATIONS IN STEEL, (In Russian), N. E. Karskii and T. I. Sobolev, Zavodskaya Laboratoriya (Factory Laboratory) v. 15, Nov. p. 1355-1358.

Apparatus indicates the increased rate of plastic deformation during austenite decomposition in the pearlite, bainite, and martensite regions and also during restoration, recrystallization, and processes taking place during annealing of quenched steel.

Russia 1949 EQUIP.

APPLICATION OF CENTRIFUGAL FORCE TO INVESTIGATION OF THE MECHANICAL STRENGTH OF METALLIC SYSTEMS (In Russian). I. I. Kornilov, Doklady Akademii Nauk SSSR (Reports of the Adademy of Sciences of the USSR), new ser. v. 67, Aug. 11, p. 843-846.

Proposes a new method for tensile and bending tests, based on the application of centrifugal force for use at temperatures up to 900°C.

EQUIP.

Russia 1949

CENTRIFUGAL METHOD FOR INVESTIGATION STRENGTH OF METALS AND ALLOYS AT HIGH TEMPERATURES, (In Russian), I. I. Kornilov, Zavodskaya Laboratoriya (Factory Laboratory), v. 15, Jan. p. 76-82.

A new type of apparatus particularly applicable for determination of the bending strength of a material in the range from room temperature up to 1200°C Conditions of testing using such a method are very close to those of practical application.

Russian 1949 EQUIP.

PORTABLE CREEP-TEST MACHINE, In Russian, M. P. Markovets and N. I. Mikheev. Zavodskaya Laboratoriya (Factory Laboratory), v. 15, Mar. p. 376-378.

Apparatus suitable for temperatures up to 900°C with a maximum load of 800 kg. Electric circuit for automatic control of temperature within ± 2°C.

Russia 1949

CREEP TEST MACHINE OPERATING AT TEMPERATURES UP TO 800°C, (In Russian), M. P. Markovets, T. N. Stasyuk, and N. N. Kolupaev., Zavodskaya Laboratoriya (Factory Laboratory), v. 15, Apr. p. 500-502.

Complete specifications for equipment in operation in the Soviet Institute of Aviation Materials.

Data on
21% Cr - 9% Ni
alloy

United States 1950

HEAT RESISTANT ALLOY COMBINES EXCEPTIONAL DUCTILITY WITH GOOD CREEP STRENGTH, Steel, v. 127, Aug. p. 104.

Mechanical properties of new 21% Cr, 9% Ni alloy (ACI Type HF). Some applications.

Data on Ingot Iron

United States 1950

CREEP TESTING COLD DRAWN INGOT IRON, Steel, v. 126, Apr. 10, p. 88-90.

Recent studies at National Bureau of Standards which reveal that resistance to fracture increases with an increase in the strain rate. Resistance to creep increased as test temperature decreased.

United States 1950

STABILITY OF AISI ALLOY STEELS AT ELEVATED TEMPERATURES, A. B. Wilder and J. O. Light, Trans. Amer. Soc. Metals, v. 42, p 917-934, dis. p. 934.

Stability of over 100 different types at 900, 1050 and 1200°F is being evaluated over a period of 10 years. Results obtained in an examination of 16 of these steels for evidence of structural changes, oxidation characteristics, and impact properties after exposure for 10,000 hours.

Approved For Release 2003/12/04 : CIA-RDP80-00926A003100040001-4

United States 1950

RESISTANCE OF SIX CAST HIGH-TEMPERATURE ALLOYS TO CRACKING CAUSED BY THERMAL SHOCK, M. J. Whitman, R. W. Hall and C. Yaker, Nat. Adv. Comm. for Aero. Tech. Note. 2037 Feb. 29 pps.

Modified wedge-shaped specimens were uniformly heated to 1750°F and subjected to a controlled water quench of one edge. This cycle was repeated until a thermal-shock failure occurred. Order of decreasing resistance to cracking was S-816, S-590, Vitalliu, 422-19, X-40 and Stellite 6.

high-temp alloys

United States 1950

FORMABILITY OF VARIOUS ALLOYS FOR HIGH TEMPERATURE SERVICE, John F. Tyrrell, Trans. Amer. Soc. Metals, v. 42, p. 405-438.

Plastic flow characteristics of 8 Fe, 5 Ni, and 4 Co-base alloys were studied in tensile tests, cup tests, drop-hammer forming, and deep-drawing tests. Results were correlated to give comparative formability ratings. 13 ref.

United States 1950

CREEP TIME LAW FOR ZINC CRYSTALS, E. P. T. Tyndall, Journal of Applied Physics, v. 21, Sept. p. 939.

Creep of suitably oriented zinc single crystals was found to follow a simple empirical law: $S = At^m$, in which S is strain (nonelastic) occurring in time t after load application and A and m are constants.

Dawson
Steel

United States 1950

HARDENED ALLOY STEEL FOR SERVICE UP TO 700 F, G. V. Smith, W. B. Seens and E. J. Dullis, Amer. Soc. for Testing Materials, Preprint 36, 11 pgs.

Miscellaneous mechanical properties of two steels, SAE 4340 and 0.40% C Ni-Cr-Mo-V, quenched and tempered to a hardness of Rockwell C-43, then tested in tension at 75, 500, 600, and 700°F, in compression at 75°F, for creep-rupture strength at 500, 600 and 700°F. and for Charpy impact strength between 75 and 315°F.

United States 1950

CREEP AND RUPTURE OF SEVERAL CHROMIUM-NICKEL AUSTENITIC STAINLESS STEELS, G. V. Smith, E. J. Dulis and E. G. Houston, Trans. Amer. Soc. Metals, v. 42, p. 935-978, dis. 978-980.

AISI Types 304, 316, 321, and 347 were investigated at 1100, 1300 and 1500°F. The nature of the microstructural changes occurring during test, the effect of these on certain mechanical properties, and the mode of fracture. 16 ref.

 19a. Zinc single crystal

United States 1950

AN UNUSUAL EFFECT IN THE CREEP OF ZINC SINGLE CRYSTALS, L. Slifkin and W. Kautzmann, Physical Review, ser. 2, v. 78 June 1, p 631-632.

Experimental procedure and results of an investigation. A curious "rest-harding" effect was found.

Data on steels + Hastelloy "C"

United States 1950

THE EFFECT OF ENVIRONMENT ON THE STRESS-RUPTURE PROPERTIES OF METALS AT ELEVATED TEMPERATURES, O. Cutler Shepard and Willis Schalliol. Amer. Soc. for Testing Materials preprint 58, 5 pps.

Stress-rupture tests in controlled atmospheres were made with low-carbon steels and with Hastelloy "C". Small differences in the composition of environment produced relatively large differences in the amount of intergranular cracking and in time to failure.

United States 1950

PROPERTIES OF METALS AT ELEVATED TEMPERATURES, G. V. Smith, Mechanical Engineering, v. 72, Oct. pp. 799-804.

Properties are classified in the broad categories: strength; other physical properties such as thermal expansivity or conductivity, elastic moduli, and the like; resistance to scaling or other corrosive attack; changes in microstructure occurring during service; and effect of these on properties. 14 references.

 Data on 'high-temp' alloys

United States 1950

LIMITING CREEP AND DESIGN STRESSES FOR CASTINGS RESISTANT TO HIGH TEMPERATURES, Norman S. Mott, Metal Progress, v. 58, Oct. p. 496B.

A table covering 14 moderate and high-temperature alloys.

Data on steels

United States 1950

THE STRENGTH OF WROUGHT STEELS AT ELEVATED TEMPERATURES, (book), R. F. Miller and J. J. Heger. 116 pgs. Amer. Soc. for Testing Materials.

Extensive tabular and graphical data cover tensile, creep and rupture properties of standard grades of both carbon and alloy steels. Includes considerable tabular material with rather complete references, also extensive curves and charts.

Co-base alloys

United States 1950

NICKEL-ALUMINUM-MOLYBDENUM ALLOYS FOR SERVICE AT ELEVATED TEMPERATURES, H. V. Kinsey and M. T. Stewart, American Soc. for Metals, Preprint No. 12, 27 pp.

The mechanical properties at 815°C that are at least the equivalent of the best Co-base casting alloys, and they can be produced under industrial conditions without difficulty. Tensile strength, creep-rupture properties, and effects of Co and W additions. Chemical specifications, one based on a 35,000 psi rupture life of 150 hour minimum at 815°C and the other on a 35,000 psi rupture life of 200 hour minimum at 815°C are developed.

 Data on ingot iron

United States 1950

INFLUENCE OF STRAIN RATE AND TEMPERATURE ON THE CREEP OF COLD DRAWN INGOT IRON, William D. Jenkins and Thomas G. Digges, Trans. Amer. Soc. Metals, v. 42, p. 1128-1129, Dis. p. 1129-1130.
Jnl. of Research of the National Bureau of Standards, v. 43, Aug. p. 117-131.

Results of a similar study for Monel and oxygen free high-purity copper were previousl reported. Since Monel and copper are face-centered cubic metals, the program was extended to include a study of the behavior of body-centered cubic iron as affected by variations in strain rate and in temperature.

 Data on Cu

United States 1950

CREEP OF ANNEALED HIGH PURITY COPPER, Tech. News Bull. (National Bureau of Standards), v. 34, Sept. pp. 130-131, Based on paper by W. D. Jenkins and T. G. Digges, Jnl. of Res. of the Nat. Bur. of Std., v 45, Aug. 1950.

Effects on creep behavior of stress, temperature, mechanical and thermal history, rate of loading, and sudden changes in both stress and temperature. Tests were made at 110, 250, and 300°F. Metallographic examination, hardness measurements, and tension tests were conducted at room temperature.

Data on Mg-Ce alloys

United States 1950

IMPROVEMENT OF HIGH-TEMPERATURE PROPERTIES OF MAGENSIUM-CERIUM FORGING ALLOYS, K. Grube, J. A. Davis, L. W. Eastwood, C. H. Lorig, and H. C. Cross, Nat. Advisory Committee for Aero. Tech. Note. 2097, May, 42 pps.

Experimental heats were made by addition of a fourth element to the base composition containing 6% Ce and 2% Mn. Tensile properties at 70° and 600°F were obtained and most compositions were subjected to short time creep tests at 600°F.

Sigma in
25Cr-20Ni-2Si
steel

United States 1950

THE EFFECT OF SIGMA PHASE ON THE SHORT-TIME HIGH TEMPERATURE PROPERTIES OF 25 CHROMIUM-20 NICKEL STAINLESS STEEL, Glen J. Guarnieri, James Miller and Frank J. Vawter. Trans. Amer. Soc. Metals, v. 42, p. 981-1000, dis. p 1000-1007.

Using a 25% Cr, 20% Ni stainless steel, with 2% Si, high-temperature tensile and creep properties (up to 100 - hr. duration) were correlated with type and pattern of sigma distribution. The hard sigma-phase constituent was found to increase materially the tensile and yield strength properties of the Cr-Ni steel up to approximately 1400°F., but a corresponding decrease in long-time creep strength properties occurred. The finely divided type of sigma structure was found desirable for minimizing room-temperature embrittlement ar indicated by bend tests.

United States 1950

METALS AT HIGH TEMPERATURES (BOOk) Frances Hurd Clar, 372 pp. Reinhold Pub. Corp,

A compilation of recent available data on high-temperature properties. Includes a theoretical discussion on plasticity and a section on test methods and manufacturing methods for heat resistant alloys.

 Datacon
Ti

United States 1950

COMPRESSIVE PROPERTIES OF TITANIUM SHEET AT ELEVATED TEMPERATURES, Paul F. Barrett, Nat. Adv. Comm for Aero. Tech. Note. 2038, Feb. 10 pgs.

Results of compressive stress-strain tests from room temperature to 800°F. Favorable compressive properties and marked anisotropy in compression were noted.

5r

United States 1950

EFFECT OF TEMPERATURE ON THE MODULUS OF ELASTICITY, Charles W. Andrews, Metal Progress, v. 58, July pp 85-89.

New data on temperature variation of Young's modulus for the following metals: Stellite 21, Inconel, four austenitic stainless steels, Armco iron, SAE 4130, and 75S Al-alloy. A dynamic method of testing was used in which the specimen is vibrated transversely at its resonant frequency.

Data on ?

United States 1950 THEORY

PROPERTIES OF METALS AT ELEVATED TEMPERATURES, G. V. Smith, Combustion, v. 21 Apr. p. 65-67; May ; 51-53.

Part I: Metal strength at elevated temperatures, working stresses that may be applied, characteristics of creep, and the relation between stress and time for rupture. A typical design chart for a stainless steel. Part II: Effects of non-constant stress and temperature, metallurgical variables, microstructural and surface changes, and scaling and corrosion.

Data on 25-0 Al

United States 1950 Theory

COMBINED TENSION-TORSION CREEP-TIME RELATIONS FOR ALUMINUM ALLOY 2S-O, Joseph Marin, J. H. Faupel and L. W. Hu, American Society for Testing Materials, Preprint 38, 17 pgs.

Investigation on the combined stress-creep properties of Alcoa 2S-O. Combined states of stress were produced by subjecting thin-walled tubular specimens of circular cross-section to various combinations of axial tension and torsion. Minimum constant creep rates for various values of the stresses and for ratios of the biaxial principal stress from 0 to -1.0 were found to be in approximate agreement with values predicted theoretically using simple tension-creep test results.

United States 1950 E Q01P1

A HIGH-SENSITIVITY TORSION CREEP UNIT, A. E. Johnson, Jnl. of Scientific Instruments, v 27, Mar. p. 74-75.

Most data on creep of metals and alloys has been obtained with stresses causing creep rates of 10^{-7} per hr. or more. Describes apparatus for measuring rates as low as 10^{-9} per hr. Legs of the torsion meter are screwed into the ends of the thin-walled tubular test-pieces used.

United States 1950

EQUIP.

PRECISION TESTING OF GAS TURBINE DISKS, Automotive Industries, v. 102, Jan pp. 40-41.

Apparatus designed for determination of plastic and creep strains at speeds up to 35,000 rpm and temperatures up to 1500°F.

EQUIP.

United States 1950

METAL BUSTER, Chemical Industries, v. 66, Apr. p. 532.

New creep and stress-rupture equipment of Babcock and Wilcox Co., Alliance, Ohio.

Equip.

United States 1950

BABCOCK & WILCOX COMPANY INSTALLS NEW LABORATORY EQUIPMENT FOR CREEP AND STRESS RUPTURE STUDIES, Industrial Heating, V. 17, June p 988, 990, 992, 994.

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United States 1950

EQUIP.

NEW LABORATORY STUDIES CREEP AND STRESS-RUPTURE, Industry and Power, v. 58, Apr. 1950, p. 103-104.

New testing laboratory of Babcock and Wilcox.

EQUIP.

United States 1950

HIGH TEMPERATURE TESTING MACHINE, Product Engineering, v. 21, May, p. 148-149, Condensed from "A High-Speed, High-Temperature Precision Testing Machine for Gas Turbine Disk Research", A. C. Hagg, B. Cametti and G. O. Sankey, presented before Society for Experimental Stress Analysis.

Gas turbine disk tester for the determination of plastic and creep strains at temperatur s up to 1500° F and rotational speeds up to 35,000 rpm.

England 1950 Theory

PROPERTIES OF METALS AT ELEVATED TEMPERATURES, (BOOk), Geo. V. Smith, 401 pgs. McGraw-Hill Book Co. (Metallurgy and Metallurgical Engineering Series).

A comprehensive summary of available knowledge on the effect of temperature on the properties of metals. Nature of plastic deformation and fracture of metals at ordinary and elevated temperatures. Effects of such variables as chemical composition, manufacturing practice, and heat treatment. Appendix describes the composition of "super-alloys".

England 1950

THE CREEP OF METALS AND ALLOYS, E. G. Stanford, Temple Press, Ltd. Bowling Green Lane, London E.C.1, England 15 s. (book).

Creep testing; the creep curve; metallurgical factors affecting creep; methods for presenting creep-test results; and mechanism of creep.

England 1949-50 THEORY

FACTORS AFFECTING THE STRENGTH OF METALS AT HIGH TEMPERATURES, A. G. Metcalfe
Metal Treatment and Drop Forging. v. 16, pp. 235-246.

A scheme for classification. By adopting a simplified picture of the mechanism, three groups of methods are obtained: first, those which raise the softening temperature; second, those by which resistance to slip may be raised; third, those which decrease the chance of failure in a grain boundary. Attempts to asses the relative importance of each factor. 48 ref.

England 1950

CREEP DUE TO FLUCTUATING STRESSES AT ELEVATED TEMPERATURES, H. J. Tapsell, P. G. Forrest and G. R. Tremain. Engineering v 170, Aug. 25, pp. 189-191, (A condensation).

Results of experimental study for the heat resisting materials Rex 78 and Minonic 80, and fr the Al-alloy RR59, also for 0.26% C steel. Experimental and theoretical data are compared.

Data on
Al-alloys

England 1950

THE MECHANICAL PROPERTIES OF SOME WROUGHT AND CAST ALUMINUM ALLOYS AT ELEVATED TEMPERATURES, P. L. Thorpe, G. R. Tremain, and R. W. Ridley, Jnl of the Inst. of Metals, v 77, Apr. p 111-140.

Results of tensile, fatigue and creep tests at various temperatures in the range 20-450°C on 17 wrought and 7 cast alloys, together with results for a form of thermal-strain test on some of the cast alloys. Materials tested included some experimental ~~xxx~~ alloys developed during the last war by the Royal Aircraft Establishment in Britain.

Data on
Cast Iron

England 1950

DEFORMATION CHARACTERISTICS OF FIVE GREY CAST IRONS AT 400DEG. C, 500 DEG. C,
C. R. Tottle, Inst. of British Foundrymen, Paper No. 973, 9 pgs. Advanced copy.

Materials, testing procedure, and temperature contorl. Rupture, short-time tensile, creep, and stress-to-rupture tests-. 15 references.

England 1950 THEORY

MECHANISM OF PRIMARY CREEP IN METALS, W. A. Wood and R. F. Scrutton, Jnl. of the Institute of Metals, v. 77, July pp 423-434.

Studied experimentally, using 99.98% Al. Micrographs and X-ray diffraction patterns illustrate results obtained, which are analyzed theoretically.

England 1950

CREEP FACTRUES, R. W. Bailey, Institution of Metallurgists, "The Fracture of Metals," 1950, p 29-41.

In relation to C-Mo steel.

Germany 1950
(England)

THE MECHANICAL PROPERTIES OF TITANIUM AT DIFFERENET TEMPERATURES, (In German), R. L. Bickerdike and D. A. Sutcliffe, Metall, v. 4, May, pp 191-193.

Small amounts of O_2 , N_2 , and Si greatly increase the hardness and tensile strength of Ti without eliminating its ductility at room temperature. Elevated temperatures greatly decrease these properties. 16 ref.

Data on Al

England 1950 THEORY

SOME X-RAY OBSERVATIONS ON THE NATURE OF CREEP DEFORMATION IN POLYCRYSTALLINE ALUMINUM, E. A. Calnan and B. D. Burns, Jnl of the Inst. of Metals, v. 77, July pp 445-455.

Back-reflection Laue patterns were taken from the same series of locations on a large-grained Al test-piece after successive amounts of creep deformation at 250°C. From analysis of the asterism and movement of the reflection spots relative to the stress axis, it appears that creep deformation up to about 3% extension in 170 hr. is associated with slip processes. Later stages are characterized by presence of numerous fine units or cells formed from the previously distorted material. 12 references.

England 1950

HEAT RESISTING STEELS: INFLUENCE OF ALLOY ADDITIONS, G. T. Colegate, Metal Treatment and Drop Forging, v. 17, Summer 1950, pp 93-101, 109.

Various types of steels and effects of small additions of other elements such as Si, Cb, Co, and Mo, to each type. Oxidation resistance, creep, tensile strength, yield strength, elongation, area reduction, proportional limit, and Brinell hardness are tabulated and charted.

Data on Grey Cast Iron

England 1950

A FEW SHORT-TIME, GROWTH AND CREEP TESTS ON AN UNALLOYED PEARLITIC GREY IRON, J. W. Grant, British Cast Iron Res. Assoc. Jnl of Res. and Dev., v. 3, June pp. 441-445.

Results of three creep tests and a growth test at 500°C and of short-time tensile tests at 400, 450, and 500°C.

Data on Al

England 1950 THEORY

THE MECHANISM OF CREEP AS REVEALED BY X-RAY METHODS, G. B. Greenough and Edna M. Smith, Jnl. of the Inst. of Metals, v. 77, July, pp 435-443.

A hypothesis is proposed to explain in terms of dislocation theory the recent observations of Wilms and Wood and of Wood and Rachinger in relation to the mechanism of deformation of metals. Some new X-ray observations on Al which support the hypothesis.

 Data on Cd Single-Crystals

England 1950 THEORY

SURFACE EFFECTS IN THE CREEP OF CADMIUM SINGLE CRYSTALS, E. O. Hall, Nature, v. 165, Apr. 15, p. 611-612.

When oxide-coated, single-crystal Cd wires are immersed in an electrolyte such as $CdCl_2$ creep rate is increased many times. However, this rate later decreases, and may stop ~~[illegible]~~ altogether due to formation of a crystalline dendrite coating. Electron-microscope investigation showed this material to be $Cd(OH)_2$. Mechanism of the creep effect is proposed.

Data on
"creep testing"

EQUIP.

England 1950

CREEP TESTING BY A CANTILEVER-BENDING METHOD, G. T. Harris and H. C. Child, Jnl of the Iron and Steel Inst. v. 165, June pp. 139-144.

Cantilever-bending creep testing is shown to have advantages over tensile testing for high temperatures and where the preparation of specimens must be reduced to a ~~xxxx~~ minimum, such as for unmachinable materials. There is good correlation between results obtained by this method and conventional testing at plastic strains up to 1.0%. Test data is for heat resisting steels.

Data on Pb + Pb alloys

~~France~~ England 1950

CREEP AND FATIGUE TESTS ON COMMERCIALLY EXTRUDED LEAD AND LEAD ALLOY PIPES, (Continued). J. McKeown and L.M.T. Hopkin, Metallurgia, v. 41, p. 219-223.

Investigation to determine the degree of reproducibility to be expected from materials produced by extrusion on commercial presses. Effect of cold work on Tadanac lead from the pipe press, on alloy of 0.005% Ag + 0.005% Cu, and on 0.015% Te lead. Effect of heat treatment on Tadanac lead from the pipe press. Fatigue tests and results.

Data on Pb & Pb-alloys

England 1950

CREEP AND FATIGUE TESTS ON COMMERCIALLY EXTRUDED LEAD AND LEAD ALLOY PIPES, J. McKeown and L. M. T. Hopkin, Metallurgia, v. 41, Jan. p. 135-143.

Reproducibility to be expected from materials produced on commercial presses. It is concluded that the effect of alloying additions cannot be determined on extrusions made on presses where variables are not under sufficient control.

England 1950 THEORY

CREEP DEFORMATION OF METALS, L. Rotherham and L. W. Larke, Research, V. 3, Sept. pp. 434-436.

Some observations of grain growth in a 0.5% Ag aluminum alloy in which the effect on creep rate was not very large. Observations suggest that the breakdown to subgrains is not the primary cause of creep, but a secondary effect resulting from creep.

England 1950

Group.

APPARATUS FOR THE MEASUREMENT OF CREEP UNDER FLUCTUATING STRESS, W. R. Tyldesley
Metallurgia, v. 42, June p. 45-48.

Stress system comprises a steady load on which is superimposed a smaller load fluctuating at the rate of 100 cycles per sec. 19 references.

England 1950 Equip.

THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION; CREEP AND FATIGUE TESTING EQUIPMENT IN THE LABORATORIES, J. McKeown, Metallurgia v. 42, Sept. pp. 189-196.

England 1950 Eng. P.

A SIMPLE CONSTANT STRESS APPARATUS FOR CREEP TESTING, L. M. T. Hopkin, Proc. of the Physical Society, v. 63 Sec. B, May 1, p. 346-349.

Simple device which can maintain stress on a creep specimen constant to within 0.8% during uniform extensions up to 100%. The apparatus is suitable for slow rates of strain. Examples of creep curves obtained for Pb and a Pb-Sn alloy. Good agreement with the Andrade creep equation was observed in both cases.

Equip.

England 1950

DESIGN AND CONSTRUCTION OF EQUIPMENT FOR A SMALL STRESS-RUPTURE CREEP LABORATORY, F. C. Child, Metallurgia, v. 42, June, p. 37-44.

Experience in the development of a creep testing laboratory for life-to-rupture tests on materials at 900°C using miniature creep testing machines. Although designed for high-temperature testing, the aparatus has given satisfactory performance, with only minor alterations, at temperatures as low as 400°C.

Data on
9.7% Cu Al
alloy + Mg

France 1950 Theory

THEORIES AND EXPERIMENTAL DATA ON CREEP AND RELAXATION OF POLYCRYSTALS, (In French) Pierre Laurent and Michel Eudier, Revue de Metallurgie, v. 47, Jan, p. 39-52.

Based on the literature and on experimental investigation of Mg and an Al alloy containing 9.7% Cu. Variation of mechanical properties during dreep and relaxation. 24 ref.

France 1950

CONTRIBUTION TO THE STUDY OF INFLUENCE OF MICROSTRUCTURE ON THE HEAT RESISTANCE OF STEEL (In French) Geor. Delbart and Michel Ravery. Revue de Metallurgie, v. 47, Mar. p. 215-233 discussion p 233-234.

Investigated for a low-alloy Cr-Mo steel produced in a basic electric furnace. Creep properties were determined at 450, 525, 550 and 575° β under loads of 7, 11, 15, and 24 kg. per sq. mm. in shortened long-time tests. Influence of heat treatment on creep properties. Microstructures corresponding to the various treatments are illustrated. 14 references.

Germany 1950

MATERIALS TESTING AND STRENGTH RESEARCH IN GERMANY IN THE YEARS 1939-1949, (In German) E. Siebel, Schweizer Archiv fur angewandte Wissenschaft und Technik, v. 12, Apr. pp 97-114.

History of materials testing in Germany. Activities and advances of materials testing during the war and its revival after the war. Strength behavior under static and vibrating stresses. 30 ref.

Germany 1950 THEORY

PRESENT-DAY PROBLEMS IN THE MECHANICS OF STRUCTURES (In German) Hans Umstatter, Zeitschrift des Vereines Deutscher Ingenieure, v. 92, Jan 21, p 57-61.

The effect of flow phenomena on such physical properties of metals as toughness, elasticity, shear strength, etc. Relaxation time as a specific variable; elastic and plastic properties of materials; creep phenomena; stress and strain; tough-elastic hysteresis; and the relaxation spectrum. 16 ref.

Germany 1950 THEORY

EVALUATION OF CREEP TESTS (In German), Nikolaus Ludwig, Zeitschrift fur Metallkunde, v. 41, Mar. p. 87-91.

The designer can apply H. Eckardt's exponential law in order to estimate, on the basis of experimentally established creep-stress results, the expected expansions, exceptions being materials with a tendency to hot shortness. If the material is to be used at temperatures exceeding 600°C, the estimates must be based on long-time creep test results. 20 references.

Al-alloys

Germany 1950

HIGH TEMPERATURE TENSILE TESTING OF ALUMINUM ALLOYS (In German) Hugo Vosskühler
Zeitschrift fur Metallkunde, v. 41, May, p. 144-151.

Reports results of tests made on a series of malleable and cast Al-alloys to determine their tensile strengths, 0.2 and 0.02% yield strengths, elongations, and area contractions between room temperature and 300°C. Results are supplemented by published data and thus expanded to -200°C. Includes graphs.

Germany 1950

CREEP OF STEEL UNDER STATIC STRESSES AT ROOM TEMPERATURE, (In German) Walter Janiche and Gunther Thiel, Archiv fur das Eisenhuttenwesen, v. 21, Mar.apr. pp 105-118.

Creep behavior of six carbon and low-alloy steels at room temperature and effects of heat-treatment and cold working when stressed below the yield point up to several hundred hours were studied. 34 references.

Germany 1950

TESTING STEELS FOR THEIR TENDENCY TO CREEP-STRESS EMBRITTLEMENT WITH U-SHAPED SPECIMENS AND BY SLOW TENSILE TESTS, (In German), Wilhelm Ruttmann, Gerhard Bandel, and Rudolf Schinn. Archiv fur das Eisenhüttenwesen, v. 21 July-Aug. pp. 225-233.

Tests were made with notched and unnotched ferritic and austenitic steel bars at 450-700°C. Comparison of results with those from long-time creep tests (3000 and 10,000 hours) shows that the described method permits relatively rapid determination of the tendency of heat resistant steels to creep-stress embrittlement. 14 references.

Equip.

Germany 1950

INSTRUMENT FOR RECORDING SHRINKAGE STRESS VS. TEMPERATURE CURVES OF METALS, (In German) Hans Scholz. Archiv fur das Eisenhuttenwesen, v. 21 Jan-Feb. p 43-47 discussion p. 48.

Design, operation, and results. The instruement can be used to study various metallurgical problems, such as the creep resistance of steels. 27 references.

Canada 1949

A NICKEL ALUMINUM MOLYBDENUM CREEP RESISTANT ALLOY, H. V. Kensey and M. T. Stewart, Canadian Journal of Research, v. 27, sec. F, Feb. p. 80-98.

Study of a series of these alloys to develop one for use uder stress at 815°C and above. Certain combinations of the three metals possess tensile strengths well over 100,000 psi. at room temperature; certain characteristic microstructures, dependent upon the Ni-Al ratio, are essential for these high strengths. Creep-rupture tests at 815°C showed that some of these alloys are superior in may respects to existing high-temperature alloys.

High ... materials

Sweden 1949

SOME EXPERIENCES WITH THE CREEP BEHAVIOUR OF METERIALS, A. Johannson, Engineers' Digest. v. 10, Oct. 1949, ; 340-342; discussion, p. 342-344, Translated and condensed from Teknisk Tidskrift, v. 79, Feb. 19, 1949, p. 127-132.

Service experience with high-temperature materials in steam turbines, gas turbines, and creep-testing machines.

SWEDEN 1949

THE MECHANICAL PROPERTIES OF BOILER STEELS AT ELEVATED TEMPERATURES (In Swedish)
Gunnar Lilljekvist, Jernkontorets Annaler, v. 133, No. 11, pp. 519-540.

Mechanical properties, especially yield points, of 14 swedish boiler steels were investigated at elevated temperatures. Average yield points at temperatures between -40 and 400°C are charted. Tensile strength, elongation, and reduction in area are also shown graphically.

Japan 1948

INFLUENCE OF CONTENTS OF CARBON, CHROMIUM, AND TUNGSTEN ON MECHANICAL PROPERTIES OF CERTAIN VALVE STEELS, (In French), S. Koshiba and K. Tanaka, Circulaire d'Informations Techniques, v. 6, Aug.Sept.Oct. 1949, p. 395-399. Translated from Tetsu to Hagane (Japanese), v. 34, Aug. 1948, p. 13-15.

Tabulated and charted data including transformation points and effects of temperatures up to 1050°C on mechanical properties and oxidation resistance show that Cr-W steels are as satisfactory for valves used at high temperatures as Cr-Si-W steels.

Japan 1949 EQUIP.

STUDIES ON THE CHANGES OF VARIOUS PROPERTIES OF METALS AND ALLOYS DUE TO TWISTING. I. (In Japanese) Nubuo Shiota and Chyoei Onozaki, Nippon Kinzoku Gakkai-Si (Jnl of the Japan Inst. of Metals), v. 13, Aug. p. 37-39.

A simple twisting machine. Equipment includes electric furnace for studies at elevated temperatures. Typical results showing transformation curves for various nonferrous alloys.

THEORY

Czech. 1950

RELAXATION AT HIGH TEMPERATURES. (In Czech.) Alexander A. Chit'kov, Hutnicke Listy, v. 5, Feb. p. 52-56.

Two theories have been proposed for correlation of relaxation and creep data (the time-hardening and the strain-hardening theories). Experimental data show that neither theory correctly represents the above relationship because relaxation differs from creep in connection with both the mechanism of plastic deformation and the nature of internal "micro-mechanical" processes. Indicates that stress relaxation must be investigated independently of creep. 17 references.

Russia 1950 Theory

LAWS OF THE CREEP OF METALS (In Russian), V. I. Likhtman, Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser., v.72, June 21, 1950 pp 1079-1082.

Creep was theoretically investigated at room, high, and low temperatures under different applied loads. Formulas are proposed which describe the constancy of internal cohesion of metal during creep. An equation for determination of the minimum rate of creep is derived and interpreted for different values of the variables.

 Data on Pb, Sn, + Cu

Russian 1950

SYSTEMATIC INVESTIGATION OF THE RATE AND TEMPERATURE DEPENDENCE OF RESISTANCE TO DEFORMATION OF SINGLE-PHASE METALS (In Russian). L. D. Sokolov. Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR), new ser. v. 70, Feb. 11, p. 839-841.

Investigation for Pb, Sn and Cu from room temperature up to their respecrive melting points and for various rates of deformation.

Russia 1950 Equip.

NEW METHODS OF COMPRESSION TESTING, (In Russian) K. K. Likharev. Vestnik Mashinostroeniqu (Bulletin of the Machine Construction Industry), v. 30 Mar. p. 51-54.

Proposes, for testing of materials in the uniaxial, uniformly stressed state, use of hollow cylindrical test specimens whose ends are conical surfaces. The concentrations of local stresses encountered in conical solid specimens is thus eliminated. Tests of mild and red-hot steel, aluminum, silumin, brass, resins, and gypsum. Formulas for calculation of data.

A REVIEW OF THE WORLD LITERATURE

ON THE

CREEP OF METALS AT ELEVATED TEMPERATURES

Purpose: The primary purpose of this survey is to determine the relative activities in the various countries of the world on the specific subject of the creep behavior of metals at elevated temperatures. A secondary objective is to ascertain, insofar as it is possible, the sources of information generally available to the U. S. S. R.

Method:

1. All readily available sources on the published data on creep of metals over the years of 1945 to the present date were reviewed and compiled in Appendix I. The principal sources of these data were:

   a. A.S.M. Review of Metal Literature, American Society for Metals, Cleveland.

   b. Metallurgical Abstracts, Institute for Metals, London.

   c. Engineers Digest, London.

Cross-references and secondary sources were investigated. Undoubtedly a few published articles may have been overlooked.

No data were available on unpublished reports of companies, scientific laboratories, or government laboratories of the countries in which it might be presumed that research is being done in the field of creep of metals. Such data could only be obtained by direct visits to foreign countries and direct discussions with the personnel engaged in this work. In some cases, e.g., the U.S.S.R., these missing data might be quite voluminous. The impression is verified by the general articles reproduced in Appendix II. Apparently most of the research being done in Russia is not reported in literature readily available to engineers and scientists in other countries. These factors must be considered when the attached data are evaluated.

2. A simple statistical method of assembling the data was used. Articles appearing in the open literature were classified as to whether they were primarily theoretical (T), whether they primarily concerned engineering data (D) or whether they were devoted primarily to equipment (E). The number of articles on creep of metals is summarized in Table I as to year and conntry.

Other methods may prove superior to this method of reduction of the data. Perhaps the number of words would have been a more significant quide as to the extent of activities in this field. Undoubtedly a critical review of the quality and uniqueness of each article would better serve the objectives of this survey. But in view of the crudity of the available information, and in view of the knowledge that this information might be quite incomplete, the easy method of analysis by articles was adopted with the hope that the qualitative trends indicated by the data might be somewhat significant.

Conclusions:

1. More than one-half of the total publications on the creep of metals over 1945 to 1950 originated in the U.S.A., whereas about one-fourth of the publications originated in England, and about one-eighth in the U.S.S.R.

a. The U.S.S.R. publications are predominantly theoretical suggesting that the investigations on creep properties for engineering data are not being published.

b. There appears to be very few publications on creep in Russian journals in 1950 suggesting that additional restrictions may recently have been placed on publications in Russia.

2. Most of the creep data available to the U.S.S.R. from sources outside of Russia probably originate in the United States of America.

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APPENDIX II

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A review of Russian metallurgical journals, their origin, history and untimely disappearance; with notes on the shifting tactics in Soviet reporting of production figures.

The Iron Curtain in Metallurgical Literature

THE EDITORIAL COMMENT and abstracts of Russian metallurgical articles published in the June issue of *Metal Progress* were of particular interest to me, because I have been concerned with Russian technical publications for several years.* The editors remark that the Russians may consider certain technical journals unsuitable for export. Quite correct! In fact, this iron curtain started to close perceptibly about ten years ago. It may be of interest to record something further regarding the ebb and flow of Soviet metallurgical journals since their comparatively recent inception.

It all started with the first five-year plan (1929). Applied to the Russian steel industry, this plan envisaged the building of such new works as Magnitogorsk (where everything is "the biggest in the world"). A frightening lack of Russian technical brains for the tasks ahead became apparent, and foreign engineers were imported. Together with this stream of experts came foreign technical journals. Understandably, the Soviets wanted journals of their own, and in the years between 1929 and 1931, a truly astounding metallurgical literature sprang up.

There was, above all, the monthly organ of the Five-Year Plan Committee for the Steel Industry, called "Soviet Metallurgy" (*Sovetskaya Metallurgiya*). This journal appealed chiefly to iron and steel engineers and also carried the monthly production figures of the "capitalistic" countries, but significantly and quite in keeping with the iron curtain mentality, not those for Russia. I have No. 1 and 2 of 1938, so the journal must have lasted at least ten years.

An even older technical journal was "Metallurgist" (*Metallurg*), a handsomely made-up monthly, started in 1926 and devoted to both ferrous and nonferrous metallurgy. The circulation rose to 4000 before this journal disappeared abruptly in 1940. During the 15 years of its existence, "Metallurgist" published more than 100 articles on metallography, 150 on rolling, more than 100 on the production of steel, almost 100 on the production of pig iron, and 130 on the production and the processing of nonferrous alloys. The level of the articles, theoretical as well as practical, was remarkably high because the section editors were the best to be found in all Russia.

In 1929, still another monthly was founded for the steel industry, entitled "Achievements of Metallurgy at Home and Abroad" (*Domes* The content was divided about equally between original contributions of a practical nature (most of them with a distinctly local slant) and detailed abstracts, often illustrated, of the foreign literature. The lit

*EDITOR'S NOTE — The author is too modest. He started translating foreign metallurgical papers on a free-lance basis in 1926, after his arrival in this country from Bavaria. Following a period with the short-lived Republic (Steel) Research Corp. in the early 1930's, he established his own organization, and has been described by one of America's most eminent metallurgists as having "uncanny ability in technical translating". Mr. Brutcher's translations are especially well known in metallurgical laboratories and research institutions.

By Henry Brutcher
[illegible]

of this journal was short; it ended with No. 10 of Vol. 7.

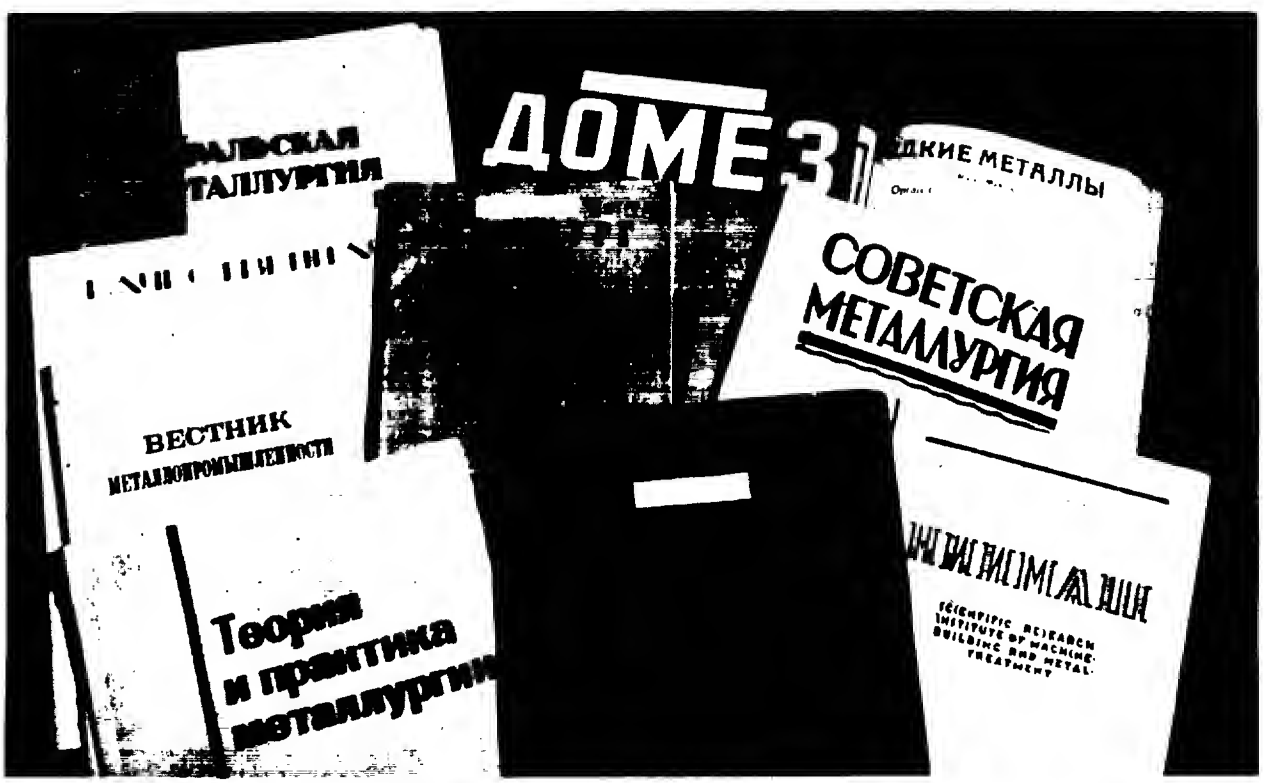
In the same year, 1929, the old "Journal of the Russian Metallurgical Society" *(Zhurnal Russkogo Metallurgicheskogo Obshchestva)* expired after a more-or-less continuous existence of almost 20 years. Among its contributors we find the names most illustrious in Russian metallurgy and metallography: D. K. Chernov, one of the early students of metals who achieved international recognition; Col. N. Belaiev, long since living in France; A. A. Bochvar, probably best known from his textbook on metallography; A. A. Baikov, a prolific writer and excellent teacher (the Academicians N. T. Gudtsov and N. V. Svechnikov, and Professors N. A. Minkevich, B. V. Stark, and M. P. Slavinskii were among his pupils). Other pre-Soviet journals possibly of interest to metallurgists were the "Bulletin of the St. Petersburg Polytechnic Institute" *(Izvestiya SPB Politekhnicheskogo Instituta)*, "Ural Technics" *(Uralskii Tekhnik)*, and the "Journal of the Russian Physical-Chemical Society" *(Zhurnal Russkogo Fiz.-Khim. Obshchestva)*. In the 1907 volume of the latter, we find a paper on the crystallization and structure of steel by A. A. Baikov, the same Baikov who in 1944 took part in a lively discussion on the use of oxygen in blast furnace operation.

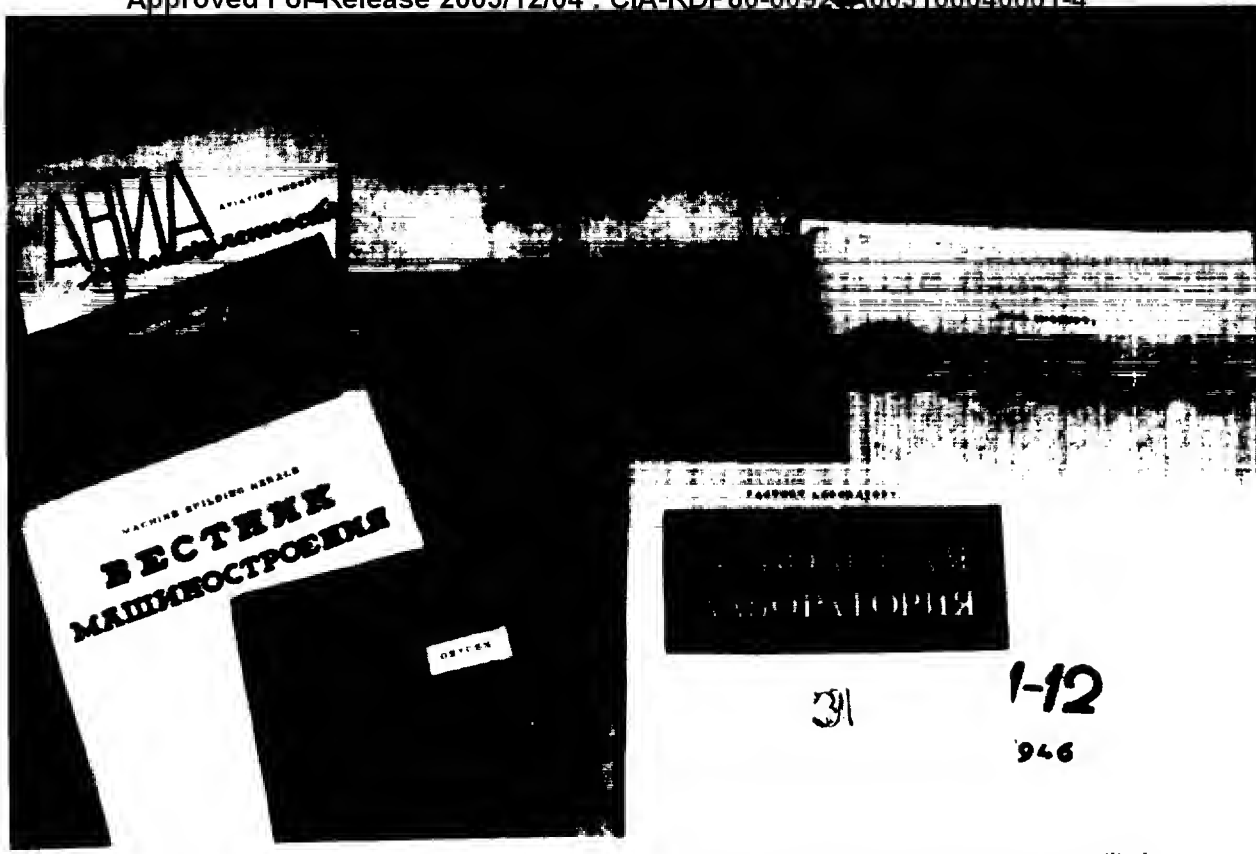
In 1930, a fourth monthly devoted entirely to ferrous metallurgy appeared under the name "Theory and Practice of Metallurgy" *(Teoriya i Praktika Metallurgii)*. Despite the duality in name, most of the papers were practical. Like "Metallurgist", this good journal disappeared without warning or a farewell, in December 1940. During the second half of its life, it paid increased attention to problems of plant construction; the rest of the articles dealt with iron and steel production, rolling, and quality control. Special attention was given to seamless tube production as, at that time, tube mills were first started in Russia.

The year 1930 was marked also by the beginning of the most important Russian journal on welding. It is still being published, and received here, under the original title "Autogenous Welding" *(Avtogennoe Delo)*, but the name must not be taken literally, as all of the welding processes receive attention. In the same year, the first issue of the Russian "Foundry" *(Liteinoe Delo)* appeared. This was an interesting experiment — each of the articles could be easily detached and filed separately according to a convenient system, and each page was fully indexed at the top. Even the translations from the foreign literature were treated in this way. It expired with No. 6 in 1941, but may since have been revived.

In 1931, the important event in Russian metallurgical literature was the appearance of "Steel" *(Stal)* in the South of Russia (Kharkov), under the editorship of the eminently able I. P. Bardin,

All of These Russian Metallurgical Journals Are Now Defunct, Except Possibly "Metal Industry Herald"





Metallurgical Journals Currently Published in the Soviet Union. Only "Autogenous Welding", "Machine Tools and Instruments" and "Machine Building Herald" are still exportable. When will they become "oversubscribed"?

member of the Academy. This journal, the fifth of the series devoted to ferrous metallurgy, contained an enormous amount of information. Each issue carried from two to four articles on each of the following subjects: blast furnace, steel production, rolling, metallography, and heat treatment. There were also papers on power economy and several detailed abstracts of important foreign papers. Without any advance warning, this fine journal ceased publication in December 1910, but in January 1911, a new one of the same name made its appearance, this time from Moscow and under a relatively unknown editor. Its coverage was no less extensive than that of the old "Steel"; however, three other worthy journals in the ferrous field had been sacrificed.

Let us go back to 1932. In that year, the journal "Rare Metals" (*Redkie Metally*) made its appearance; its columns were devoted to metals such as beryllium, zirconium, columbium, tantalum, tungsten and uranium, and a number of other metals which in this country would not be considered rare (for example, molybdenum, tin, mercury and lithium). Retractory carbides also received much attention in "Rare Metals". It disappeared with the first issue of 1938. Another journal, "Light Metals" (*Legkie Metally*), covering aluminum and magnesium also expired in 1938.

A third nonferrous journal, called "Colored Metals" (*Tsvetnye Metally*) has been enjoying a longer life. When, in 1941, it merged with "Gold Industry" (*Zolotaya Promyshlennost*), it acquired the name "Colored Metallurgy" (*Tsvetnaya Metallurgiya*); however, it has since resumed its old name and appears six times a year. The Russian journal with French title, *Annales de l'Institute de Platine et des Autres Métaux Précieux*, which in 1936 changed its name to "*Annales du Secteur de Platine, etc.*", recalls the fact that Russia has always had a most important share in the world's production of platinum and that the first bona fide platinum coins were struck in that country (but not for long — the dollar value of a 3-ruble piece, $2.30 when struck, would now be about $200.00).

Several Russian journals have carried articles in non-Russian languages at various times, and the foreign language translations of the tables of contents have always been an indication as to which way the political wind was blowing. Just before the last war, they were in English and French; before that, often in German; during the Soviet friendship with Hitler, they were consistently in German; for a short while after the war, in English; when the French entered an alliance with the Soviets in about 1946, also in French; and

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Russian Metallurgical Journals

(Starts on p. 331)

most recently, since the Soviets have lost all their "friends" among the Western powers, the tables of contents have been just plain Russian.

In 1932, a sixth journal devoted to ferrous metallurgy was started, "Urals Metallurgy" (*Uralskaya Metallurgiya*). Its articles were of a practical slant, often very interesting. Most of them, of course, reflected the specific needs of the Urals district. This journal disappeared in December 1940.

From today's point of view, the most important journal which made its appearance in the early 1930's is "Factory Laboratory" (*Zavodskaya Laboratoriya*). Although the name does not indicate it, this is a predominantly metallurgical journal; it covers the fields of analytical chemistry, physical and mechanical testing of metals, as well as chemical and metallurgical laboratory apparatus. Fortunately, this journal has survived the various purges, although it discontinued publication between July 1941 and December 1944. The content of "Factory Laboratory" is practical and, with the possible exception of the papers on home-made laboratory apparatus, holds considerable interest outside Russia today. In 1950, however, only a few exchange copies seem to have come through.

In 1933, a seventh journal for ferrous metallurgy appeared in Moscow, "Quality Steel" (*Kachestvennaya Stal*). It was attractively made-up, and carried interesting, practical, original articles that were relatively short and often written from fresh, if controversial, viewpoints, dealing exclusively with alloy steels and ferro-alloys. Personally, I liked it best because most of the papers were so brief and to the point. When this fine journal was in its sixth year, the by now well-known ax fell and we have the tragicomic picture of a journal whose editors were so utterly unaware of their impending fate that in the very last issue, on the very last page, they printed a set of instructions on how to prepare papers intended for publication in their journal!

So much for the strictly metallurgical journals. There are many others that carry research papers on metallurgy, chiefly the physical and chemical publications of the Academy that are shown in the illustration below. Specialized periodicals in other branches of technology also print articles of interest to metallurgists. For instance the field of refractories is ably covered by "Refractories" (*Ogneupory*), which was started in Moscow in 1933. The content of this journal is theoretical as well as practical and, as a rule, on a creditable level. Each issue contains a few papers on combustion engineering, but that subject has lately been taken over by the journal "Oxygen" (*Kislorod*). Started in Moscow as a bimonthly, while the war was still on, in 1941, it covers all phases of the use and transportation of oxygen and, in particular, it contains research data on the use of oxygen in both the steel and nonferrous metals industries.

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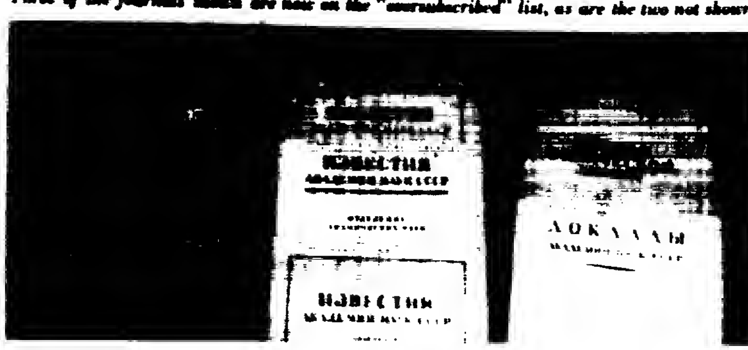
These Seven Journals of the Academy of Sciences of the U.S.S.R. Occasionally Contain Papers of Interest to Metallurgists. The titles translated are: (left) Journal of Applied Chemistry and Journal of Technical Physics; (center) three sections of the Bulletin of the Academy of Sciences of the U.S.S.R. Physical Series (at top), Technical Science, and Chemical Science; (right) Journal of Physical Chemistry, and Reports of the Academy of Sciences of the U.S.S.R. The Journal of Experimental and Theoretical Physics and the Acta Physicochimica belong in this picture but copies were not available for photographing. Three of the journals shown are now on the "unsubscribed" list, as are the two not shown.



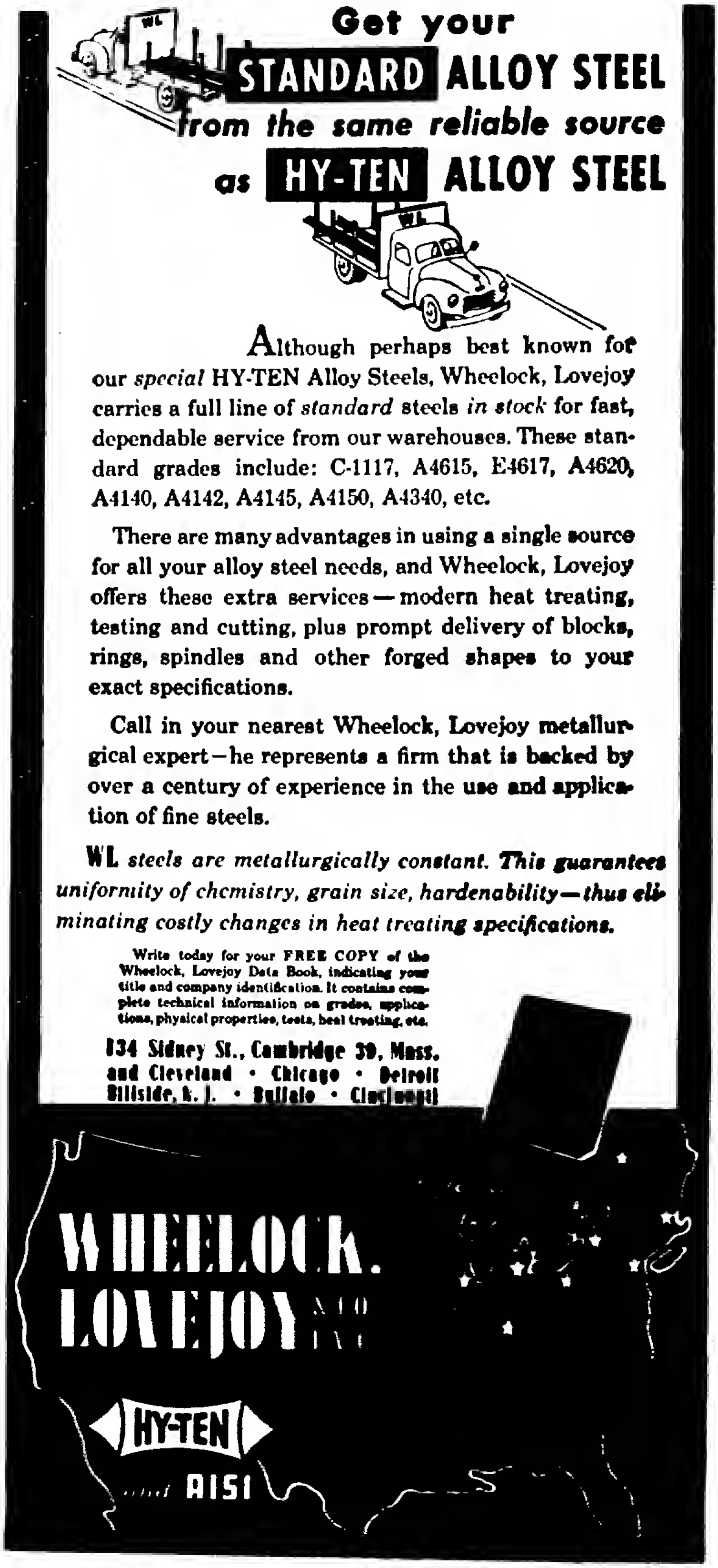
Russian Journals

(Starts on p. 331)

Although the editorial in *Metal Progress* for June stated that scant information is available on Russian machining practice, there *is* a Russian journal devoted entirely to machining practice and theory and it is still coming in strong. The name of this journal is *Stanki i Instrument*, usually translated "Machine Tools and Instruments", although "Machine Tools and Hand Tools" would probably be more accurate. In earlier years, the level of the contributions was nothing to get excited about, but their quality has been visibly improving of late. This journal publishes the Soviet standards on hand tools and machine tools after they have received official sanction. The whole gamut of cutting and grinding operations is covered; there are also valuable papers on chip formation, surface finish and methods of appraising it, and related topics. Each volume contains a small number of papers concerning the metallography and heat treating of toolsteels, and problems of machinability are dealt with. This journal pays close attention to new developments reported in *American Machinist* and *Machinery*.

The journals mentioned so far have been more or less thoroughly abstracted in this country. There exists also a whole flock of highly specialized journals relating to metallurgy, modeled after the German house organs. The following deserve mention: "Central Bureau for Ferrous Metals" (*Glavchermet*), "Southern Metallurgy" (*Yugomet*), "Urals Metallurgy" (*Uralmet*), each serving one of the so-called trusts. There were also special magazines for the blast furnaces in Sverdlovsk, the coke plants in Kharkov, the auxiliary rolling-mill machines in Sverdlovsk, and so on. Whether or not these magazines have survived the last war, I do not know; however, two years ago there was published by the Stalin KM Works a "Collection of Scientific-Technical Papers" on ferrous metallurgy, and a similar symposium must be credited to the Ilyich Works in Mariupol (Southern Russia). Lesser plants have issued small mimeographed bulletins with technical information. For example, the metallurgical works in Chusovaya (Urals Dis-

(Continued on p. 372)



Russian Journals

(Starts on p. 331)

trict) publishes the "NITO Bulletin" (NITO is short for Society of Engineers and Technicians of the Chusovsk Metallurgical Works). At least a quarter of the 19 issues which appeared in 1946 and 1947 is devoted to papers on steel melting, 10% on the blast furnace, 25% on rolling. There are also a great many original research data for example, on vanadium slag. The entire volume of papers contains 103 pages with 159 illustrations.

Production Figures — It is, of course, well known that no Russian journal publishes gravimetric or volumetric data on production for stated periods of time. Even the weekly or monthly publications of individual works or trusts never state how many tons of pig iron or steel were produced and what the yields were. About all they say is that plant A has fallen short of, or exceeded, the production goal by so many per cent.

In contrast to the custom of other countries, "production" at least in the years preceding the last war was, for instance, the quantity of metal run out of a furnace without regard to its soundness or suitability; thus, "production" included all the scrap and rejects. At the rolling mill, "production" was what went into the mill in the form of ingots or blooms, and not what came out of it. Another example will illustrate this even better: An order had been issued to the tractor plant in Stalingrad to produce 40 tractors per day. So day after day, 40 tractors left the sheds; maybe one of them could move out under its own power; the rest were pulled out and then finished outside the gates. Thus was the "production goal" reached!

At the time when the heavy industries were started, production figures of this kind, of course, gave an entirely wrong picture of the situation. There can be no doubt that, in the years 1929 to 1933, the production figures published were not attained. In the years after 1933 until about 1937, however, the figures published were more likely to reflect actuality, and after March 1937, the opposite procedure was adopted and figures published were

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Russian Journals

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lower than those actually reached.

In the summer of 1941, the German High Command released a reference book in which the capacity of the Russian industry was detailed for the different branches. There were data on the capacity of the furnaces, the plants, the number of workers, and so on. This book had been compiled on the basis of such data as had been published previously in the Russian technical literature. When German experts entered Russia in the wake of the German armies (and this information comes from one of those experts) they found that, in actuality, production was considerably *higher* than indicated in their reference book and that the potentials calculated on the basis of their lists were wrong.

Another example of the element of surprise and mystery concerns wire-drawing dies. On Nov. 28, 1941, a German committee on wire drawing was in session and (according to the minutes) it developed that Russia had placed an order for multiple wire-drawing machines to be operated at such high speeds that the well-known Krupp Widia dies used in them simply could not stand the pace. The Russian purchasing commission, however, was not surprised at all and hinted that maybe they had the right die material and, at any rate, they would accept the machines. To this day, no positive information on the new die material has leaked out, so far as I am aware.

The peculiar reciprocity of the Soviet Government in the patent situation may be cited also. Our Patent Office library in Washington has not received full Russian patent specifications issued in recent years; all it has are brief abstracts of these specifications. On the other hand, anyone here may secure full copies of our own patent specifications at a nominal fee and no questions asked.

As far as is known to me, there has been no considerable expansion in the Russian metallurgical literature within the past two or three years, such as has taken place in other countries — for instance, Ger-

(Continued on p. 376)

Russian Journals for Metallurgy

(Starts on p. 331)

many, England, Australia, Spain and Brazil. However, the quality of the papers, which ten years ago still was quite spotty, has improved. Statements of an author that are not supported by factual data, and shortcomings in experimental procedure, are now in for a reprimand, in the form of an editor's note.

The acquisition of Russian journals — so far as they are obtainable — has been simplified. There is only one channel: The Four Continent Book Corp., 38 West 58th St., New York 19, whose most recent list of available periodicals carries 208 items, including numerous propaganda mediums (The Reader, Culture and Life, Soviet Sport, Soviet Art, Labor, Problems of History, The Peasant Woman, The Young Bolshevik, Crocodile). It also carries an "Important Notice!" listing 22 journals that are "oversubscribed and not available for 1950". Sad to relate, "Factory Laboratory" and "Journal of Technical Physics" were placed in the oversubscribed category about the time *Metal Progress* was running its June issue with Russian abstracts from these two journals.

And what will happen if you try to break through the iron curtain to secure technical literature directly from individuals? Here is my story: About three years ago, the address of one Comrade X, research engineer at an Institute in the Urals region appeared in the Letters to the Editor column of an American weekly. Comrade X seemed eager for foreign literature and hence a good candidate to exchange journals with, so I suggested trade to him and actually received a postcard expressing his interest in the proposal and promising to look into the possibilities of obtaining back issues of certain journals for me. Then, after a few months, I was asked, not by Comrade X, but by a Detroit firm, would I kindly pay them the sum of $27.50 covering a book on spectrographic analysis plus five standard samples to go with it, so that they could forward the book and samples to Comrade X. In the meantime, I had received from Comrade X three copies (one of them useless) of a

(Continued on p. 378)

Russian Journals for Metallurgy

(*Starts on p. 331*)

journal I wanted, so I sent the money. After that, silence descended and there was no answer to my pleas that three badly soiled magazine copies were really less than I had expected to get for \$27.50! I do not know if Comrade X is to blame—probably he is not, because regulations were just then issued governing relations between Russians and non-Russians, and possibly Comrade X did not want to be transferred from his comfortable post in Sverdlovsk to less cheerful surroundings in Siberia.

I shall conclude this commentary with an evaluation of the position of Russian metallurgical literature when compared with that of other countries. Thirteen years ago, Dr. H. F. Mehl of Carnegie Tech made a careful survey of the number of research articles in the metallurgical field which had appeared in practically all the scientific literature of the world in the preceding two years.* In compiling the number of articles from the various countries, he found that the quantities produced had the following relation:

Germany	7
United States	4
England	2
Russia	2
France	1
Japan	1

He added that if *quality* of the articles were considered, the United States would be unlikely to improve its position.

If someone were asked to repeat this performance for today's metallurgical literature, he might arrive at the following numbers:

United States	7
England	3
Germany	3
Russia	?

Any such comparisons are apt to be challenged and I will gladly bow to challenges based on actual count. There is no doubt, however, that in the 1937 evaluation, Russia would have received a better rating if the Russian journals had been more fully and adequately abstracted at that time. Today, we simply do not know. The iron curtain is drawn too tight.

*National Resources Committee, 1937, paper on Technical Trends and National Policy, p. 364.

the punch. On such a punch the gap could be $\frac{1}{2}$ in. between punch and supporting pressure plate for forming 0.025-in. thick steel. This gap can be increased to $\frac{3}{4}$ in. if the gage is increased to 0.050 in. The gap can be $\frac{1}{16}$ in. with 0.025-in aluminum, and $\frac{3}{8}$ in. with 0.050-in. aluminum.

In conclusion it may be said that results so far have been most satisfactory. Representative parts that would require at least 15 min. bench work can now be made without any attention by the "tap-tap" department. The largest blank we have formed so far is about 28 x 31 in., but the only limitation in this respect is the size of the equipment available. Another possibility, as yet not well explored, is the forming and simultaneous shearing in any direction. So much interest has been shown in the process by engineers throughout the metallurgical industries generally, that Hydropress, Inc., has been licensed to manufacture the equipment for general use in hydraulic presses. We are inclined to believe that mechanical presses might also be used, if the press is powerful enough and if the jaw opening is sufficiently wide to mount an auxiliary Marform unit.

The Organization of Iron and Steel Research in Russia

The following statements on organization of ferrous metallurgical research in the U.S.S.R. are quoted from an article by G. Delbart in Revue de Metallurgie *for April 1949. This extract is followed by editorial remarks concerning the publication of Russian metallurgical papers. Beginning on p. 798 are printed extended abstracts of five recent articles from Russian technical journals. Of particular interest is the description of a magnetic method of determining the hardenability of steel (p. 816), a method which, properly calibrated, would seem to have several advantages over the widely used end quench test. Also abstracted are papers on multiple-arc welding of thin sheet metal (p. 808), effect of grain size on the high-temperature strength of austenitic alloys (p. 798), tests for forgeability (p. 838), and effect of alloying elements on the hardness of ferrite (p. 802).*

BEFORE 1914 scientific metallurgical research was carried on in the laboratories of advanced technical schools, the universities, large factories and large arsenals. Metallurgy was taught in the School of Mines of St. Petersburg, founded in 1773. The Polytechnic School of St. Petersburg had a program analogous to the French Polytechnic School. At the School for Roads and Bridges, founded in 1810, there was a center for testing materials. A large central testing laboratory was also started before 1914, and one of its branches was directed by the metallographic scholar, N. Belaiew. Other institutions such as the Upper Technical School, of which Dimitri Tchernoff (1839-1921) was a product, and the Polytechnic Institute of Lesnoye should not be forgotten. Scientific research in general and metallographic science in particular were in full swing by 1914.

After the war of 1914-18 and the civil war that followed, the Soviet government reorganized teaching and research and founded a considerable number of advanced technical schools and research institutes all over the U.S.S.R. At the present time the number of these institutions and large industrial laboratories is more than one thousand. The institutes can be separated into four groups: the

Academy of Sciences, advanced schools, institutes of (properly speaking) research, and laboratories of industrial research.

The Academy of Science boasts institutes which are among the best equipped in the world, notably an Iron Institute, in Moscow, with a branch in the Urals. Its budget is directly approved by the Council of Ministers and its president is one of the Council of Ministers of the U.S.S.R. The Government entrusts the Academy of Sciences with basic work most important to the national interest, and the Academy controls in principle all research undertaken in the U.S.S.R.

The Soviet universities generally do not concern themselves much with iron; however, some ten of the advanced technical schools include ferrous metallurgical instruction and research. These researches are financed by the ministry supporting the school or by an industrial group, but the general program must be submitted to the approval of the Ministry of Education which controls all schools, even those depending on other ministries.

Each ministry has its own institutes of research. The Iron Ministry has eight institutes. The main one is in Moscow; other well-equipped ones are at Sverdlosk in the Urals, at Stalinsk in western Siberia, and at Dniepropetrovsk. Researchers are allowed to use the results of their work to obtain university degrees. A thesis for the degree of "candidate" requires about two years of experimental work; a thesis for the doctorate of science about five years. Along with a university degree, particularly that of doctor of science, goes an appreciable increase in salary and other material advantages.

Most of the work undertaken is due to the initiative of the researchers, but in order to receive the necessary financial support they must furnish a detailed plan, state precisely the goal to be attained and promise completion of their project in a rather short time. When laboratory work is to be extended to industry, the researcher is usually given supervision and even the execution of factory tests, or experiments in the semi-industrial pilot plants attached to the institutes.

Soviet Metallurgical Publications

A RECENT Russian textbook ("Metallovedenie", by A. A. Bochvar) contains an appendix evaluating the metallurgical publications of various countries. The four principal Russian journals are given there as: *Stal* (Steel), *Tsvetnie Metally* (Nonferrous Metals), *Izvestiya Sektora Fiziko-himicheskova Analiza* (Bulletin of the Branch of Physico-Chemical Analysis), and *Zhurnal Teckhnicheskoi Fiziki* (Journal of Technical Physics). Only the last of these is received and abstracted regularly in the United States.

Papers of metallurgical interest are by no means limited to the four principal mediums. Seventeen Russian journals are annotated in the "A.S.M. Review of Metal Literature", and in 1948 the Review carried references to 125 Russian articles, of which 70% were in the following four categories:

Analysis and Testing	36%
Joining (chiefly arc welding)	15
Properties of Metals	11
Constitution of Alloys	8

This distribution of subjects should not be regarded as typical of metallurgical activity in the Soviet Union. It is more likely an indication of the type of literature considered exportable. Also, the preponderance of articles on mechanical and chemical testing is due chiefly to the large number of short articles appearing in one journal, *Zavodskaya Laboratoriya* (Factory Laboratory). Papers about foundry operations, for instance, are missing; and scant information is available on machining practice, although the annual production of machine tools in the U.S.S.R. has been reported as increasing from 55,000 units in 1939 to 1,300,000 planned for 1950.

Ten of the 17 Russian journals covered by the A.S.M. Review are issued by the Academy of Sciences of the U.S.S.R., which publishes a long list of *Bulletins*, *Journals* and *Reports*. One finds in the Academy publications a great variety of metallurgical information — all the way from electron density of alloys to such unacademic subjects as the heterogeneity of steel ingots and the preheating of fuel in a shaft furnace.

There is also another type of article which appears occasionally under the standardized title, "The Priority of Russian Science With Respect to Knowledge Concerning . . ." Regardless of the accuracy of any particular claim to priority, the Russian metallurgists *are* currently turning out some important research. American chemists have recognized the value of Russian chemical literature, as indicated by the fact that two Russian chemical journals are being republished here in English and sold on a subscription basis for $80 and $95 yearly. A similarly comprehensive project for translating and republishing metallurgical papers may or may not be feasible, but the American metallurgist should not blind himself to a vast and varied amount of research and development being carried on throughout Eurasia. Perusal of the five extended abstracts beginning on p. 798 of this issue will give the reader some indication of the type of research being reported.

I. R. S. I. D.

(INSTITUT DE RECHERCHES DE LA SIDÉRURGIE)

L'organisation de la Recherche Sidérurgique en France et à l'Étranger (*)

par G. DELBART

La recherche dans l'industrie sidérurgique a été longtemps le fait de savants isolés, simplement curieux de découvrir les vérités cachées de la nature, ou d'ingénieurs audacieux décidés à pousser jusqu'au bout la réalisation de leurs idées.

Les pionniers de la recherche partirent à l'aventure en terre inconnue; ils posèrent des jalons sur les routes qu'ils parcoururent, d'autres les suivirent qui exploitèrent les résultats de leurs découvertes. L'individualisme était alors chose naturelle, il avait sa grandeur.

S'il était possible dans le passé à l'individu animé par une idée-force ou un idéal, d'agir seul avec des moyens précaires, il lui devient de plus en plus difficile dans les temps présents de progresser seul. La plupart des terrains vierges sont au moins partiellement défrichés, dans leurs parties les plus accessibles. Il faut parfaire ce défrichement ou mettre en exploitation des terres nouvelles: ceci demande du matériel, des équipes. Sans doute, les grandes découvertes seront-elles encore souvent accomplies par des hommes de génie, mais leur mise en application est déjà le fait de collectivités. Les preuves matérielles sont là, et nous ne reprendrons pas les discussions philosophiques sur la question de savoir s'il faut ou non organiser la recherche.

L'importance du développement de la recherche dans une industrie particulière devrait normalement être en relation avec l'importance de cette dernière. Voici, pour les années 1938 et 1947, la production annuelle, en millions de tonnes d'acier, des principales nations sidérurgiques :

	1938	1947
Etats-Unis d'Amérique	28	77
U.R.S.S.	18	19
Grande-Bretagne	10,5	12,7
Allemagne	20	2,7 (1)
France	6,2	5,6
Belgique	2,8	2,9
Italie	2,3	1,7
Tchécoslovaquie	1,7	2,2
Canada	0,7	1,9
Luxembourg	1,4	1,7
Suède	0,97	1,2
Indes	0,9	1,2
Australie	1,2	1,2
Japon	6,4	0,9
Espagne	0,44	0,57

(1) En 1946.

Comment la recherche sidérurgique est-elle organisée dans ces différentes nations? C'est ce que nous essaierons de montrer à la lumière d'une documentation soit puisée directement dans les pays visités, soit tirée indirectement d'informations venues des pays lointains.

Les documents rassemblés sont disparates en qualité et en quantité. Je les ai contrôlés ou fait contrôler sur place chaque fois que la chose a été possible, mais je suis cependant convaincu qu'ils présentent des lacunes et des insuffisances, et m'en excuse.

(*) Conférence faite à la Maison de la Chimie, le 18 janvier 1949.

ETATS-UNIS D'AMÉRIQUE

La recherche industrielle aux Etats-Unis s'est fortement développée entre 1920 et 1940 (fig. 1), et ce développement a subi une impulsion considérable au cours de la dernière guerre mondiale.

Dans un pays aussi vaste, la concentration de la recherche à l'échelon national peut paraître difficile, mais de toutes manières, le régime libéral qui y règne et l'existence de groupes industriels puissants se prêtaient bien à la décentralisation. C'est ce que l'on observe lorsqu'on examine la structure des organismes de recherches. Ceux-ci sont d'origines différentes, ils dépendent notamment :

1° de la profession : sidérurgie et industries mécaniques;

2° des industries métallurgiques apparentées : nickel molybdène, vanadium;

3° des universités;

4° des organismes nationaux;

5° des laboratoires de recherches privés.

Il n'existe pas, à proprement parler, d'Institut National de Recherches Sidérurgiques.

1° **La profession** est, de loin, celle qui entretient le mieux la recherche sidérurgique. Celle-ci est surtout pratiquée dans les laboratoires des sociétés importantes comme l'United States Steel Corporation, la Bethleem Steel Corp., la Republic Steel Corp., l'Union Carbide, l'Inland Steel, l'Alleghany Ludlum Steel...

Ces Sociétés qui maintiennent normalement un contact étroit avec les Universités, possèdent en général un laboratoire de contrôle dans chacune de leurs usines et un laboratoire central plus spécialement chargé des recherches. Elles consacrent à la recherche des sommes importantes (fig. 1), qui ont été considérablement augmentées depuis le début de la dernière guerre mondiale. Par exemple, l'United States Steel Corp. a un état-major de 3.000 ingénieurs de recherches; son laboratoire central est à Kearny (New-Jersey) ; il est dirigé par le Dr J.-B. Austin, et s'occupe principalement de recherches de base.

Parmi les filiales de l'U.S. Steel Corp., la Carnegie Illinois Steel Corp. de Pittsburg possède un laboratoire central qui fait un peu de travail de base, mais s'occupe surtout des problèmes d'étamage et de galvanisation; la National Tube Cº étudie à Pittsburgh les problèmes relatifs à sa spécialité, et l'American Steel and Wire Cº étudie à Cleveland l'étirage des fils et des ressorts. L'U.S. Steel Corp. a également fondé, en 1947, à Duluth (Minnesota), un laboratoire très important pour le traitement des minerais.

L'industrie automobile et de constructions mécaniques fait des recherches dans le domaine plus limité de la métallurgie-physique : propriétés des métaux et traitements thermiques.

2° **Des Sociétés alliées à la Sidérurgie,** comme l'International Nickel C°, la Climax Molybdenum C°, la Vanadium C° of America, [illegible] laboratoires puissants qui étudient les aciers et [illegible] dans la mesure où ceux-ci sont alliés au Ni, Mo [illegible]

3° **Dans les Universités,** [illegible] taie a tout naturellement une place de premier plan [illegible] la recherche appliquée n'en est pas pour cela [illegible] en particulier les recherches intéressant la défense nationale pour lesquelles ces organismes reçoivent des [illegible] et des crédits importants de l'Etat.

Les laboratoires spécialisés des Universités [illegible] également de l'Industrie des contrats de recherches (ces contrats, toujours limités en temps et en crédits, sont parfois traités par l'intermédiaire des associations techniques sans capitaux, comme l'American Society for Testing Materials (A.S.T.M.), l'American Welding Society [illegible] lorsqu'il s'agit de recherches intéressant l'ensemble de la profession.

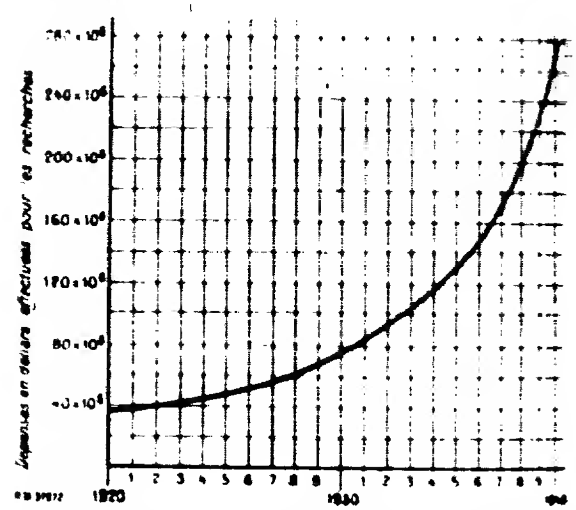

FIG. 1. — *Dépenses en dollars consacrées de 1920 à 1940 à la recherche dans l'industrie des Etats-Unis (Tiré du mémoire de M. Mauzin : La recherche technique. Son organisation, son rôle en Suisse et aux Etats-Unis, mai 1947).*

Les Universités technologiques montrent une tendance à se spécialiser soit dans la métallurgie chimique (physico-chimie des métaux à l'état liquide), soit dans la métallurgie physique (étude des diagrammes d'équilibre à l'état solide et des propriétés des métaux).

Les Universités les plus importantes du point de vue de la métallurgie chimique sont situées dans l'Est. Ce sont :

a) Le Massachusetts Institute of Technology, à Boston (c'est la plus importante des écoles polytechniques américaines; elle étudie, notamment, les problèmes de traitement des minerais de fer sous la direction du professeur Gaudin) ;

b) le Carnegie Institute of Technology, à Pittsburgh;
c) la Purdue University.

L'enseignement de la métallurgie physique est donné plus spécialement à :

— l'Institute of the Study of Metals (de l'Université de Chicago) ;
— à Notre-Dame University;
— à la Purdue University;
— à l'Université de Californie, à Berkeley;
— et aussi au Carnegie Institute of Technology.

On trouve également des laboratoires de métallurgie dans les autres Universités, mais les laboratoires de recherches y sont moins importants.

Au California Institute of Technology, où l'on forme surtout des ingénieurs-mécaniciens, un cours sur la physique des métaux est enseigné.

Ces Universités maintiennent avec l'Industrie, pour laquelle elles travaillent également, un contact permanent, et disposent souvent de crédits importants. Par exemple, l'Université de Michigan dépense pour la recherche environ 20 millions de dollars par an, dont 200.000 dollars pour la métallurgie.

Les chercheurs débutants gagnent, dans les Universités, environ 250 dollars par mois; leur salaire dans l'industrie serait de 25 à 50 % plus élevé. Les chercheurs accomplis peuvent atteindre 450 à 500 dollars. Le cadre des professeurs comprend, dans l'ordre croissant de la hiérarchie, les « Assistant Professors », les « Associate Professors », les « Full Professors »; ces derniers reçoivent un traitement de 600 à 700 dollars maximum, tandis qu'un chef de service de l'industrie gagne en moyenne 800 à 1.000 dollars et parfois même 1.200 à 1.500. Mais le professeur ajoute généralement à son traitement officiel des honoraires de conseiller technique. La loi de l'offre et de la demande joue d'ailleurs férocement et il est fréquent qu'un tourneur gagne plus qu'un ingénieur et un souffleur de verre plus qu'un professeur d'université.

4° Dans les **organismes nationaux,** l' « Office of Scientific Resarch and Development » finançait pendant la guerre des recherches intéressant surtout la défense nationale. Celles-ci étaient faites dans des laboratoires privés, dans les Universités, dans la division métallurgique du Bureau of Standards ou au Bureau of Mines, tous deux organismes d'Etat.

Le **Bureau of Standards** est, comme son nom l'indique, spécialisé dans les questions d'étalonnage et de mesures, mais possède également un département de métallurgie pour les recherches relatives aux métaux.

Le **Bureau of Mines** a pour mission la mise en valeur des ressources naturelles du pays. Son activité est très décentralisée et les contrats qu'il passe avec l'Industrie et les Universités sont d'une application très souple.

Le Bureau of Mines ne fait pas de recherches sur la physique des métaux, mais s'applique particulièrement à l'étude de la transformation des minerais et métaux. Il possède de nombreuses stations où l'on étudie les minerais sidérurgiques, en particulier celles de Minneapolis, de Salt Lake City, de Tuscaloosa, de Boulder City, de College Park. Il possède également des départements de métallurgie et d'électro-métallurgie; en particulier, des travaux très importants sur la thermochimie sont poursuivis depuis de nombreuses années à la station de Berkeley, en Californie.

L'U.S. Navy finance, de son côté, des recherches intéressant la défense nationale.

Enfin, la Commission de l'Energie Atomique fait exécuter pour son compte des recherches sur les métaux résistant aux températures élevées.

5° Aux Centres de recherches industriels nationaux et universitaires viennent s'ajouter des **Instituts de recherches privés** à but lucratif ou non. Les résultats des recherches confiées à ces Instituts appartiennent généralement à l'industriel qui a posé le problème, et ne sont alors pas publiés.

Les plus importants d'entre eux, du point de vue sidérurgique, sont :

— le Battelle Memorial Institute;
— le Mellon Institute of Industrial Research;
— l'Armour Research Foundation

viennent ensuite :

— le Midwest Research Institute,
— le Southern Research Institute;
— le Southwest Research Institute;
— le Standford Research Institute (California et Pacific North West).

Le **Battelle Memorial Institute** (Colombus, Ohio) est une institution fondée en 1929, par un don de Gordon Battelle. C'est un laboratoire privé, travaillant sans bénéfice et installé dans de très beaux bâtiments avec un équipement acheté et renouvelé grâce aux revenus du don. Les dépenses des recherches faites en 1947 ont atteint 4.250.000 dollars, soit environ 25 % pour la métallurgie.

Plus de 250 recherches y étaient en cours, la même année, dont 60 % financées par l'industrie et 40 % par le Gouvernement. Le personnel est passé de 860, au 1^{er} janvier 1947, à 1.028 au 1^{er} décembre 1947; 60 % sont des techniciens, 40 % appartiennent aux personnels administratif et auxiliaire.

Le **Mellon Institute of Industrial Research** a été fondé en 1906, d'après un programme établi par le D^r Robert Kennedy Duncan, qui permettait d'appointer des « fellows » faisant des recherches dans les Universités pour les industriels. Jusqu'en 1927, l'Institut fit partie de l'Université de Pittsburgh. Depuis lors, il est dirigé par un état-major responsable envers le Conseil, par l'intermédiaire du Directeur. L'Institut coopère avec l'Université de Pittsburgh et ses membres peuvent y passer leurs examens, mais les « fellows » du Mellon Institute ont le statut des travailleurs salariés.

En 1947, les dépenses pour la recherche pure et appliquée se montaient à 2.697.982 dollars. Le personnel comprenait 295 « fellows » et leurs 280 aides. En 1947, 80 projets de recherches, financés par les industriels, étaient en cours, dont 6 depuis trente ans et plus.

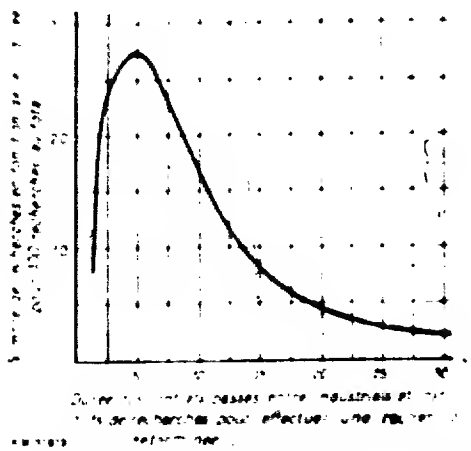

Fig. 2. — (Tiré du mémoire de M. Mauzin : La recherche ... Son organisation ... en ... et aux États-Unis, mai 1947).

2 depuis vingt-cinq ans, 9 depuis quinze ans et 19 depuis dix ans (fig. 2). Cet Institut fait des recherches de chimie et de chimie-physique pures.

L'**Armour Research Foundation of the Institute of Technology** a été fondé à Chicago en 1936. C'est une Société particulière, bien qu'elle dépende en partie du Président et du Conseil d'administration de l'Illinois Institute of Technology. Depuis sa fondation, cette organisation vit entièrement par elle-même, entretenant son personnel et son équipement.

En 1947, les recherches subventionnées par l'Industrie et le Gouvernement se sont montées à 2.551.854 dollars. Sur 105 projets de recherches en cours au 1er septembre 1947, 39 étaient subventionnés par le Gouvernement et 66 par l'Industrie.

La Fondation comprend trois divisions :

1° la division des recherches;

2° la division des mesures magnétiques;

3° la division des recherches internationales.

Cette dernière division a été organisée récemment pour faire des recherches pour les gouvernements et les industriels étrangers; elle a son siège à Mexico City.

La division des recherches comprend des départements de Physique, Chimie et Industries Chimiques, Métaux, Céramiques et Produits minéraux, Electricité, Mécanique appliquée, Industries mécaniques.

Le personnel était de 488 personnes au 1er septembre 1947, dont 322 savants et techniciens. Parmi eux, 12,5 % assurent la direction des recherches scientifiques et techniques, 59 % sont des chercheurs, savants ou ingénieurs; les 28,5 % restants sont des assistants techniques et scientifiques.

Le **Midwest Research Institute** a été organisé en 1945, à Kansas City; il fonctionne comme une institution de recherche indépendante, à but lucratif, travaillant à la fois pour l'industrie et le Gouvernement ... c'est un laboratoire de recherches régional travaillant au développement des ressources naturelles des ... Middle-West. On y fait peu de recherches ... mais surtout agricoles, chimiques ... mécanique appliquée.

Le **Southern Research Institute**, ... mingham (Alabama), fondé en 1945 et soutenu ... souscriptions privées et des dons, travaille ... protégeant les intérêts des commanditaires ... notamment sans publication des résultats.

Les dépenses de recherches se sont élevées ... à plus de 300.000 dollars, 40 études en cours ... bre 1947, dont 69 % pour l'Industrie, 15 % ... Gouvernement, 14 % pour la biochimie et 2 % ... leur propre compte.

L'effectif s'élève à 80 personnes, dont 40 techniciens; il y a un département de métallurgie.

Le **Southwest Research Institute** a été fondé ... 1947, près de San Antonio, par un don de Tom Sl... Un deuxième laboratoire sera installé à Houston pour ... pétroles. On n'y fait pas encore de métallurgie.

Le **Standford Research Institute** a été créé ... ment en coopération par les industriels de la Californie et de la région Pacifique Nord-Ouest. C'est une organisation sans bénéfice faite pour entreprendre tous types de recherches pour l'industrie et le gouvernement. Il est équipé pour faire des recherches sur l'organisation du travail, les marchés et aussi des recherches techniques de Physique, Chimie, Mécanique, Biologie.

Bien qu'entièrement séparé des Universités, il est cependant en liaison avec elles.

L'**Engineering Research Association** ... **come**, à Minneapolis, a été fondé à la fin de la guerre par un groupe de savants et ingénieurs qui avaient travaillé de concert pour la Marine et ont décidé de continuer leurs recherches sous forme d'entreprise privée. Ils profitent de la direction, de l'organisation administrative et des facilités de la Northwest Aeronautical Corp. Ils ont actuellement des bureaux à Washington et Minneapolis, et ont un effectif de 450 membres faisant surtout des recherches appliquées, sous contrats, dont le montant s'élève à plus de 3 millions de dollars par an.

Comme on le voit, il existe aux Etats-Unis d'Amérique une floraison de laboratoires de recherches ... giques : laboratoires industriels et universitaires, instituts de recherches privés qui possèdent parfois des moyens égaux et souvent supérieurs à ceux des instituts nationaux des pays de grandeur moyenne comme la France, l'Angleterre et l'Allemagne. Les contrats passés par l'Etat ou par l'Industrie, avec ou sans l'intervention des Associations techniques, assurent une coordination satisfaisante des efforts. A cet égard, le War Metallurgy Committee of the National Academy of Sciences a joué pendant la guerre un rôle important.

Il semble, d'après certains grands professeurs américains, que la recherche sidérurgique aux U.S.A. soit trop dirigée vers les applications immédiates et l'on déplore que, même dans les Universités américaines, les sommes consacrées à la recherche pure soient trop faibles par rapport à celles accordées à la recherche pratique.

U.R.S.S.

La recherche scientifique sidérurgique était pratiquée, avant 1914, dans les laboratoires des Ecoles Supérieures Techniques, des Universités, des grandes usines et des grands arsenaux.

L'enseignement de la Métallurgie était donné à l'Ecole des Mines de Saint-Pétersbourg, fondée en 1773. L'un des anciens élèves de cette école les plus connus fut le général P. Anossoff, qui, au début du XIX^e siècle, avait installé un laboratoire métallographique dans les usines de Zlatooust (Oural), dont il était le Directeur. L'Ecole Polytechnique de Saint-Pétersbourg avait un programme analogue à l'Ecole Polytechnique française; elle eut sur le mouvement scientifique une influence certaine. A l'Ecole des Ponts et Chaussées, fondée en 1810, existait un centre d'essai des matériaux qui fut dirigé un certain temps par le professeur Belopolsky. De nombreux savants français y furent professeurs, en particulier Clapeyron, Lamé, Rocourt; un Français, A. de Bétancourt, en fut le premier directeur jusqu'en 1824.

Un grand laboratoire central pour les essais de matériaux avait également été créé avant 1914, sous les auspices du Ministère de la Guerre. L'un de ses services était dirigé par le savant métallographe Belaiew. D'autres institutions comme l'Ecole Technique Supérieure, d'où sortirent D. K. Tchernoff, et l'Institut Polytechnique de Lesnoyé ne sauraient être oubliées. La recherche scientifique en général et la science métallographique en particulier, étaient, vers 1914, en plein essor et entretenaient avec la science française une liaison étroite.

D'une manière générale, les Ecoles d'Ingénieurs pratiquaient la recherche appliquée à la métallurgie, tandis que l'Académie Impériale des Sciences se préoccupait surtout de science pure.

Après la guerre 1914-18 et la guerre civile qui lui succéda, le Gouvernement soviétique s'occupa de réorganiser l'enseignement de la recherche et fonda sur toute la surface de l'U.R.S.S. un nombre considérable d'écoles techniques supérieures et d'instituts de recherches. Le nombre actuel de ces institutions et des grands laboratoires industriels dépasse aujourd'hui un millier.

Ces instituts peuvent se répartir en quatre groupes :

1° l'Académie des Sciences;

2° les Ecoles Supérieures;

3° les Instituts de recherches proprement dits;

4° les laboratoires de recherches industriels.

L'Académie des Sciences qui a pris la suite de l'ancienne Académie Impériale a été réorganisée vers 1931. Elle possède des Instituts qui sont parmi les mieux équipés du monde, et notamment un Institut de Sidérurgie, à Moscou, avec filiale dans l'Oural. Son budget est directement approuvé par le Conseil des Ministres et son président fait partie du Conseil des Ministres de l'U.R.S.S.

Le Gouvernement confie à l'Académie des Sciences les travaux de base et ceux d'intérêt national les plus importants, et celle-ci contrôle en principe les recherches entreprises sur tout le territoire de l'U.R.S.S.

Un certain nombre de républiques soviétiques possèdent leur Académie des Sciences propre, mais naturellement de moindre importance que l'Académie de l'Union.

Les Universités soviétiques s'occupent généralement peu de sidérurgie; par contre, il existe une dizaine d'Ecoles Supérieures Techniques, ayant à leur programme l'enseignement et la recherche sidérurgique. Ces recherches sont financées par le Ministère dont relève l'Ecole ou par un groupe industriel, mais le programme général doit être soumis à l'approbation du Ministère de l'Education Nationale qui contrôle toutes les Ecoles, même celles qui dépendent des autres Ministères.

Chaque Ministère possède ses propres instituts de recherches. Le Ministère de la Sidérurgie en possède huit: le principal est à Moscou; d'autres bien équipés sont à Sverdlosk, dans l'Oural, à Stalinsk, en Sibérie Occidentale, à Dniepropetrovsk. Les chercheurs des Instituts de recherches sont autorisés à utiliser les résultats de leurs travaux pour l'obtention de grades universitaires. Une thèse pour le grade de « candidat » demande environ deux ans de travail expérimental, une thèse de doctorat ès sciences, environ cinq ans. L'obtention d'un grade universitaire et surtout celui de docteur ès sciences comporte une importante augmentation de salaire et des avantages matériels appréciables.

La plupart des travaux entrepris sont dûs à l'initiative des chercheurs, mais ceux-ci doivent, pour obtenir les moyens financiers nécessaires, fournir un plan détaillé, préciser le but à atteindre et indiquer un délai d'exécution généralement assez court. Les résultats sont contrôlés et le chercheur doit pouvoir expliquer ses travaux en détail. Son compte rendu final doit être présenté quinze jours avant l'expiration du délai.

Les plans individuels sont discutés par le Conseil de l'Institut; leur ensemble constitue le programme de l'Institut pour l'année suivante.

Lorsque les travaux de laboratoire doivent avoir leur prolongement dans l'industrie, le chercheur est généralement chargé de la surveillance et même de l'exécution des expériences en usine, ou dans les ateliers-pilotes semi-industriels propres aux Instituts.

Le développement des Instituts de Recherches en U.R.S.S. ne date que de 1930. On ne connait pas grand chose de leurs travaux, mais il semble que leurs efforts portent plus sur l'accroissement de la production et les applications immédiates que sur les recherches de base.

GRANDE-BRETAGNE

La recherche sur le plan national

La recherche scientifique en Grande-Bretagne est patronnée par le Department of Scientific and Industrial Research (DSIR) créé pendant la guerre 1914-1918. Le DSIR dépend de la présidence du Conseil; son Conseil comprend des savants, des industriels, des représentants du Gouvernement.

Le DSIR embrasse toutes les branches de la science et ses applications. Il anime :

1° les recherches d'intérêt national;
2° les recherches de base dans les Universités,
3° les recherches appliquées dans l'industrie.

Pour les recherches d'intérêt national, le DSIR a sous sa direction des laboratoires et, en particulier, le « National Physical Laboratory ».

Dans les Universités, il a créé des bourses d'études et donné des subventions. Les possibilités de ces Universités sont grandes, mais elles demandent encore à être développées.

Du côté de l'Industrie, le DSIR a favorisé la formation d'organismes coopératifs spécialisés dont le financement est assuré en partie par lui-même et en partie par l'industrie.

La recherche appliquée a pris un grand développement; elle est faite parallèlement dans les laboratoires universitaires et industriels.

L'industrie sidérurgique anglaise possède des laboratoires bien équipés et réputés; leur importance a doublé depuis 1939.

La recherche corporative tient une place particulièrement importante. Les dépenses qu'elle occasionne sont passées, depuis dix ans, de 300.000 à 1 million de livres par an.

La recherche dans la sidérurgie

Trois grands organismes dominent l'activité technique et scientifique de la sidérurgie :

— la British Iron and Steel Federation;
— l'Iron and Steel Institute;
— la Bristish Iron and Steel Research Association (B.I.S.R.A.).

La **Federation** ou Chambre patronale de la Sidérurgie, a pour but essentiel d'assurer la bonne marche de l'Industrie, de contrôler la production par des études économiques et statistiques, de juger de l'opportunité des installations nouvelles du point de vue économique, de vérifier, avec l'aide du BISRA, que ces nouvelles installations sont bien « up to date », c'est à dire qu'elles appliquent les connaissances les plus récemment acquises dans les domaines scientifique et technique.

L'**Iron and Steel Institute** représente la société savante chargée de stimuler les activités scientifiques et techniques par l'étude en commission de sujets déterminés, les publications, les cours de perfectionnement, les congrès, les relations avec l'étranger. Certaines de ces tâches sont faites avec le concours de la Fédération et du BISRA.

Le **BISRA,** dirigé par Sir Charles Goodeve, est plus spécialement chargé de l'exécution des recherches, soit dans ses laboratoires propres de Londres (Battersea), de Birmingham, de Hillport, de Swansea, soit dans les laboratoires d'Université, du National Physical Laboratory ou des usines, avec lesquels le BISRA passe des contrats. Le schéma de son organisation est donné dans la figure 3. D'un côté sont classés les départements de recherches avec leurs laboratoires, ou leurs bureaux; de l'autre, les divisions ou services chargés de coordination

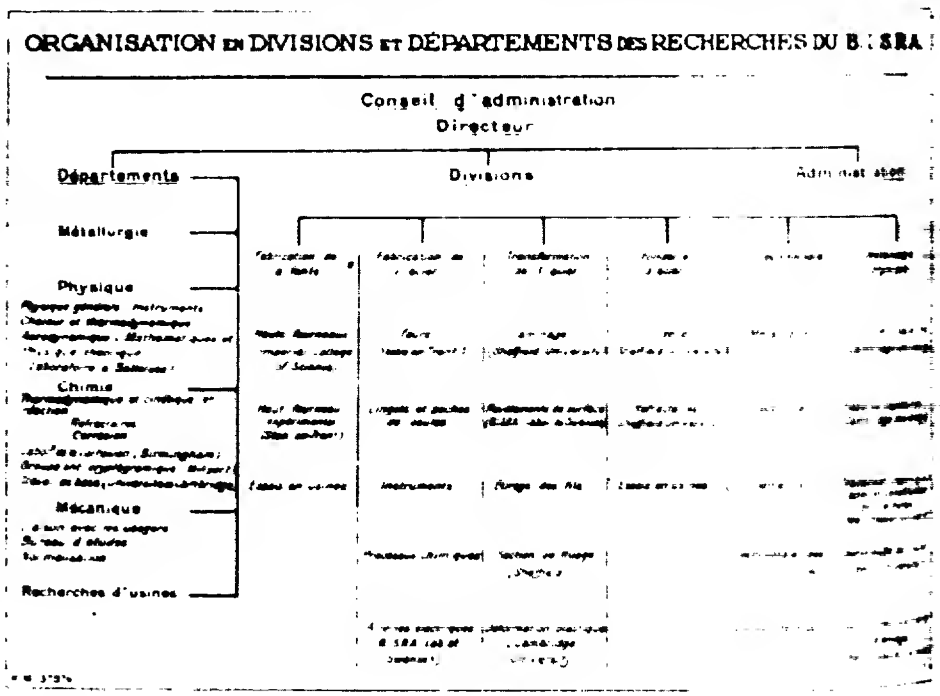

Fig. 3.

et de suivre les recherches faites à l'extérieur. Parmi les départements, signalons les suivants : la métallurgie, la physique, la chimie, la mécanique; parmi les services : la fabrication de la fonte, la fabrication de l'acier, la transformation de l'acier, la fonderie d'acier, la technologie, la métallurgie physique.

Naturellement, les liaisons et les accords sont établis avec les organisations corporatives voisines, en particulier avec la British Coke Association et la British Refractories Research Association.

Comme nous l'avons vu, le BISRA possède plusieurs laboratoires propres et il envisage d'en construire d'autres.

Le plus important d'entre eux est le laboratoire de physique de Battersea, dirigée par Mr. W. Thring.

Ce laboratoire occupe une soixantaine de personnes, réparties dans des services administratifs et surtout dans les cinq divisions de recherches suivantes :

1° Physique générale;
2° Instruments de mesure;
3° Chaleur et thermodynamique;
4° Mécanique des fluides;
5° Mathématiques statistiques.

Ce laboratoire a été installé de 1946 à 1947 et a déjà produit un certain nombre d'études intéressantes sur les applications industrielles de la physique.

Le financement du BISRA est assuré, partie par l'Iron and Steel Federation, partie par l'Etat.

ALLEMAGNE

Il semble que l'organisation de la recherche au sein de la profession et à l'échelle nationale ait été conçue et réalisée en Allemagne, bien plus tôt que dans les autres pays d'importance sidérurgique à peu près équivalente. Déjà, en 1911, existait à Berlin une Kaiser Wilhelm Gesellschaft zür Förderung der Wissenschaften (K.W.G.); celle-ci vient de prendre le titre de « Max Planck Gesellschaft ».

Cette Société, au capital de 15 millions de marks-or, s'était donnée pour but de créer des instituts dans lesquels les chercheurs seraient dégagés des charges de l'enseignement. Elle avait créé, entre autres, en 1912, un Institut de Recherches pour la houille à Mulheim, dans la Ruhr.

Bien avant cette époque (1860), existait une puissante association d'ingénieurs, de techniciens et de patrons qui, après plusieurs dénominations, prit le titre de **Verein Deutscher Eisenhüttenleute** (1881). Cette association suscitait l'étude en commun des problèmes techniques intéressant la profession. Elle comprenait, en 1938, 6.686 membres et disposait d'une bibliothèque de 68.000 ouvrages. Les études techniques étaient dirigées par des Commissions spécialisées de 10 à 20 membres chacune, dont les principales étaient les suivantes :

1° Minerais;
2° Hauts fourneaux;
3° Aciers Martin et Thomas, produits réfractaires;
4° Laminoirs;
5° Matériel métallurgique;
6° Essais de matériaux.

Le président de ces Commissions est choisi parmi les spécialistes les plus actifs et les plus aptes à présider aux discussions. Pendant longtemps, il fut difficile de faire participer les membres aux controverses; mais les Commissions prirent une vie plus intense à la suite du remplacement des autodidactes par de jeunes ingénieurs diplômés.

Le président de chaque Commission est aidé par un ingénieur appointé par le Verein, remplissant les fonctions de secrétaire, d'organisateur et d'agent de liaison.

Le rôle principal des Commissions est de déterminer les sujets qui méritent d'être mis à l'étude et de trouver le praticien capable de résoudre chacun d'eux.

Les Commissions établissent des plans de travail et répartissent éventuellement le travail dans les usines. Celles-ci ne montrèrent pas toujours la meilleure volonté pour ce travail collectif, surtout tant qu'il y eut des dirigeants autodidactes. Par la suite, le travail en commun devint la règle, ce qui n'empêchait pas les usines d'étudier pour leur propre compte des problèmes particuliers, et de prendre des brevets. Les études corporatives furent plus lentes à s'établir parmi les aciéries fines, mais leur ralliement se réalisa cependant peu à peu.

Le travail ayant été réparti et exécuté, les rapports sont adressés séparément au secrétariat de la Commission, rassemblés et coordonnés par lui. Le rapport d'ensemble est présenté au cours d'une réunion par le secrétaire de Commission et la discussion a lieu sous l'impulsion du président. Rapports et discussions sont généralement publiés. Tous les deux mois environ a lieu une réunion plénière des Commissions d'ingénieurs.

Les publications du Verein sont *Stahl und Eisen*, qui reproduit de préférence les mémoires techniques, et l'*Archiv für das Eisenhüttenleute*, plus scientifique. Cette séparation des publications techniques et scientifiques s'est révélée utile pour satisfaire les ingénieurs et les chercheurs.

Le service de documentation tient ses fiches au jour le jour; les tableaux de référence peuvent ainsi paraître dès la première quinzaine de janvier pour l'année précédente.

Parmi les créations signalées comme particulièrement efficaces, on cite les « Wärmestelle », stations de contrôle thermique qui comprenaient trois bureaux (Ruhr, Sarre, Haute-Silésie) avec douze ingénieurs au total, qui allaient d'usine en usine dans le but de leur faire réaliser des économies de combustible.

Le Kaiser Wilhelm Institut für Eisenforschung

En mars 1917, le Dr Springorum, président du Verein, affirmait la nécessité pour la métallurgie allemande d'unir la recherche scientifique à la pratique pour faire face à la concurrence mondiale d'après guerre et, en particulier, en vue d'aider à l'étude expérimentale et pratique des travaux des Comités du Verein. A la suite de cette déclaration, les usines allemandes s'engagèrent, le 19 juin 1917, à fournir pendant dix ans les fonds nécessaires à la construction et au fonctionnement des laboratoires. Sur le plan scientifique, le nouvel institut fut affilié à la Kaiser Wilhelm Gesellschaft.

Le professeur Wüst fut désigné par le Gouvernement comme directeur de l'Institut, en novembre 1917. De 1920 à 1921, on transforma en laboratoires des bâtiments d'usines. Le professeur Wüst fut remplacé, en décembre 1922, par son adjoint, le professeur Korber. Des laboratoires définitifs furent construits en 1935, sur un terrain de 8 hectares offert par la ville de Dusseldorf. L'ensemble des constructions — laboratoires, halles d'usinage et de laboratoires lourds, annexes, couvre environ 4.600 m², dont 1.500 pour le laboratoire central et la bibliothèque et 3.100 pour les halles. La surface utile des laboratoires est de 5.600 m². L'effectif s'élevait, en 1936, à 130 personnes; il dépassa 150 par la suite.

Le K.W.I. était, en 1938, divisé en cinq départements :

1° Minerais;
2° Métallurgie générale;
3° Métallographie;
4° Chimie et chimie-physique;
5° Physique.

Les départements de métallurgie générale et de chimie ne faisaient qu'un à l'origine; ils furent séparés par la suite. Cette division qui paraissait logique au moment de la mise en route de cet Institut est aujourd'hui critiquée par ses propres dirigeants, prétextant que les sujets d'études résolubles par une seule technique, comme on [illegible] et que les problèmes actuels ne peuvent être [illegible] fondis que moyennant le concours de toutes les [illegible] d'un même laboratoire. De plus en plus, la recherche expérimentale devient le fait d'une équipe et non d'un homme et l'individualisme excessif est un obstacle au progrès. Ainsi, la mise au point de la préparation du ferro-manganèse, à partir du minerai russe à 2,5 % de phosphore, fut faite non par le département des [illegible] mais par les divisions métallurgique et chimique, la sidérurgie mit au point la conduite du haut fourneau, la chimie le traitement par les alcalino-terreux pour [illegible] des phosphures ultérieurement transformés en phosphates.

Liaison du K.W.I. et du Verein

Les sujets d'études du K.W.I. sont choisis par le directeur, aidé de ses collaborateurs scientifiques, il s'inspire évidemment des demandes et désirs exprimés par les Commissions d'ingénieurs. Les relations du président du Verein et du directeur du K.W.I., désigné par le Gouvernement, étaient étroites, par suite de la bonne entente qui unissait ces deux personnalités, mais n'étaient pas réglementées. Les faits valent mieux que les règlements, cependant, peut-être est-ce une lacune que cette liaison n'ait pas été prévue formellement. Le directeur actuel du K.W.I. est le professeur Wever, il a remplacé le professeur Korber, mort de maladie en 1944.

Le Verein fournit la moitié des fonds du KWI grâce aux versements effectués par les usines. Cette contribution est assurée par une taxe à la vente des fontes et aciers, librement consentie par la Max-Planck-Gesellschaft, successeur de la Kaiser-Wilhelm Gesellschaft. Le programme du K.W.I. englobe tous les problèmes métallurgiques, depuis la préparation du minerai jusqu'aux essais des produits finis.

Les études de base y ont une large part, mais le K.W.I. collabore aussi avec l'industrie sur les problèmes techniques.

FRANCE

La recherche scientifique et technique dans l'industrie sidérurgique française remonte déjà loin, et il suffit de rappeler les noms d'Osmond, Héroult, Martin, Charpy, Le Chatelier, L. Guillet..., et ceux d'une génération plus jeune : MM. Portevin, Chevenard, Chaudron, Perrin, et bien d'autres encore, pour être convaincu à la fois du dynamisme français et de son individualisme. C'est en effet souvent seuls et libres de leurs initiatives, avec des moyens matériels limités, que ces savants ont réussi de belles découvertes. C'est aussi souvent dans les laboratoires d'usines et toujours sous l'impulsion d'initiatives privées que ces recherches furent entreprises et menées à bien.

Mais, comme le dit Louis de Broglie : « Si les grandes découvertes sont le plus souvent l'œuvre d'un seul, le développement de leurs conséquences et leurs applications exige généralement la coordination de nombreux efforts. »

La recherche collective devient aujourd'hui une nécessité. La Sidérurgie française l'a ainsi compris et a décidé de créer un Institut de Recherches pour la Profession. Celui-ci, bien loin d'annihiler la recherche libre l'encouragera en ouvrant ses fenêtres toutes grandes aux effluves du dehors, en s'efforçant d'éviter tout dogmatisme et en assurant des liaisons inexistantes jusqu'alors.

La recherche corporative en France commença à s'organiser en 1939 sous l'égide du Comité des Forges, alors présidé par M. de Wendel, par la création de **Commissions d'Ingénieurs.**

Ces Commissions, au nombre de 14, groupaient des spécialistes qui se réunissaient sous la présidence de l'un d'entre eux, choisi pour sa compétence particulière. Elles

avaient pour but de mettre à l'étude les problèmes intéressant leur spécialité, de provoquer des échanges de vue et la mise en commun des expériences propres à chacun.

Ces Commissions étaient les suivantes :

- Coke;
- Hauts fourneaux Thomas;
- Hauts fourneaux autres que Thomas;
- Aciéries Thomas;
- Aciéries Martin;
- Aciéries électriques;
- Laminoirs de l'Est et du Nord;
- Laminoirs du Centre;
- Traitements thermiques Centre;
- Traitements thermiques Est et Nord;
- Utilisation des combustibles;
- Produits plats;
- Moulage de l'acier;
- Produits réfractaires.

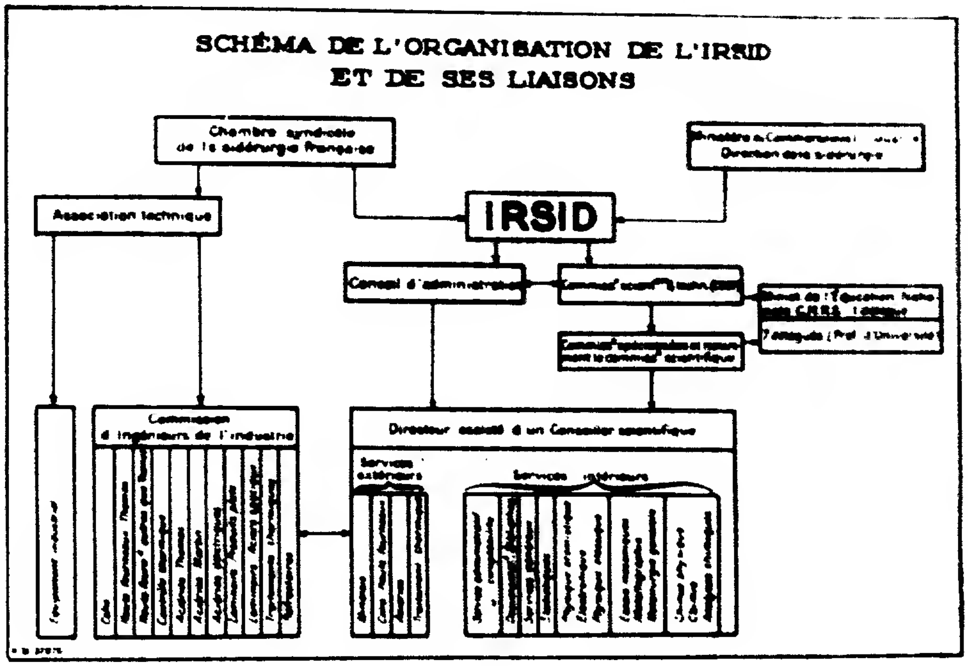

Fig. 4.

Chacune de ces Commissions s'était réunie plusieurs fois et certaines s'étaient révélées d'une vitalité prometteuse, lorsque survinrent la guerre et l'occupation qui les mirent complètement en sommeil.

Elles furent reconstituées, sous l'autorité de l'Association Technique, en décembre 1945, sauf celle du moulage de l'acier que le Centre Technique de la Fonderie, récemment mis en place, avait déjà rétablie. Le secrétariat général de ces Commissions est assuré par M. Georges Grenier, de la Chambre Syndicale de la Sidérurgie.

Les sujets traités par ces Commissions sont d'ordre technique, mais la technique pose toujours incidemment des problèmes scientifiques lorsqu'on veut pousser un peu loin les investigations.

L'organisme corporatif capable d'aider les Commissions d'ingénieurs, soit par l'étude au laboratoire des problèmes posés par ces Commissions, soit pour l'exécution en usine de recherches à l'échelle industrielle, n'existait pas, mais le projet de sa création était dans l'air depuis 1938, époque à laquelle M. Lambert-Ribot, à l'instigation de M. Portevin, avait obtenu du Conseil de Direction du Comité des Forges, le principe du financement d'un tel organisme par une taxe à la tonne de fonte ou d'acier.

Vinrent la guerre et l'occupation... Les choses en restèrent là jusqu'en 1943. Mais une poignée d'hommes qui avaient gardé confiance dans les destinées de la France, préparaient l'après-guerre. Sous le patronage de M. J. Aubrun, la Commission d'Etudes Scientifiques et Techniques (C.E.S.T.), alors présidée par M. Taffanel et plus tard par M. H. Malcor, chargeait l'ingénieur Jean Rist des études relatives à la création du Laboratoire de Recherches de la Sidérurgie. Celui-ci établit avec ardeur le plan d'organisation et l'avant-projet des laboratoires. Les rapports furent approuvés; ils devaient servir de base de départ aux réalisations matérielles. Jean Rist rejoignit, en 1944, les Forces Françaises de l'Intérieur, et fut tué le 21 août dans un combat d'arrière-garde; en souvenir de son œuvre créatrice et de son sacrifice, le nom de Jean Rist devait être donné, le 19 juin 1948, au premier bâtiment des futurs laboratoires de **l'Institut de Recherches de la Sidérurgie** (IRSID), construit à Saint-Germain-en-Laye.

La figure 4 donne le schéma de l'organisation de l'IRSID. Celui-ci dépend de la Chambre Syndicale de la Sidérurgie; il est également contrôlé par la Direction de la Sidérurgie du Ministère de l'Industrie et du Commerce et par un contrôleur d'Etat du Secrétariat d'Etat aux Affaires Economiques. Il possède un Conseil d'Administration qui définit sa politique générale et contrôle sa gestion financière.

La discussion du programme général des recherches est assurée par un Conseil Scientifique et Technique (COST), présidé par M. H. Malcor. Les sujets d'études adoptés sont examinés dans des Commissions spécialisées dont la principale est la Commission scientifique présidée par M. Chevenard, membre de l'Institut.

Le Directeur, aidé d'un conseiller scientifique, M. A. Portevin, membre de l'Institut, administre, organise, coordonne.

Les liaisons avec l'Industrie sont normalement assurées par l'intermédiaire des Commissions d'ingénieurs, les contacts avec l'Université, par la Commission Scientifique qui comprend sept professeurs d'Universités désignés par le Centre National de la Recherche Scientifique qui dépend du Ministère de l'Éducation Nationale, mais naturellement des relations directes sont aussi établies avec l'Industrie par les Chefs des Services extérieurs de l'IRSID et avec l'Université par les Chefs des Départements de recherches.

Les services extérieurs comprennent des services et stations :

1° Minerais avec station d'essais à Saulnes;

2° Coke et haut fourneau avec bureau à Longwy;

3° Aciéries.

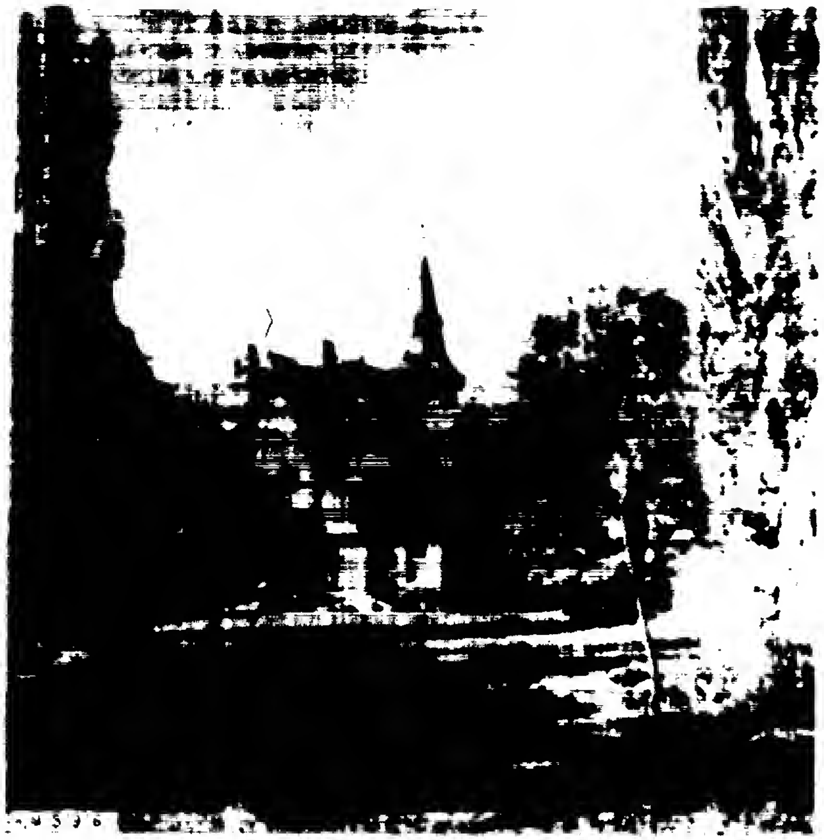

Fig. 5. — Villa existant dans le domaine de l'IRSID, actuellement occupée par les bureaux et laboratoires provisoires.

Les services se divisent, pour le moment, en trois départements et trois services :

— Physique et statistiques;
— Métallographie et essais mécaniques;
— Chimie et chimie-physique;
— Services généraux (atelier d'usinage, services électriques, appareillage) ;
— Services administratifs et comptables;
— Documentation et bibliothèque.

Les bureaux et des laboratoires provisoires ont été installés dans l'immeuble existant dans le domaine de Saint-Léger, à Saint-Germain-en-Laye, acquis par l'IRSID fin juillet 1946 (fig. 5). Les laboratoires, très exigus pour le moment, pourront prendre de l'extension lorsque les bâtiments Jean Rist seront terminés, ce qui est prévu pour la fin 1949, mais n'atteindront leur plein développement qu'après l'achèvement des laboratoires scientifiques, prévu pour fin 1951.

Outre son activité propre, l'IRSID a établi des Commissions mixtes avec les industries voisines, les houillères, la fonderie, la peinture (revêtements antirouille), dans lesquelles sont discutés les problèmes communs.

Les laborat... de l'IRSID ... cours de ... avec le concours ... l'architecte R. Ca... lon, dont la maquette est représentée à la figure 6 ... comprennent :

1° Le bâtiment Jean Rist ... tion, ateliers de ... sion, de transforma... tion, d'usinage, laboratoires ... mécaniques, ... ment à une surface de plancher de 4.627 m²;

2° Le laboratoire central d'une surface de plancher de 8.200 m², comportant une aile pour la chimie et la chimie physique, une aile pour la physique. Ces deux ailes se conjuguent par un bloc central dans lequel sont distribués les services administratifs, comptables et de documentation.

La puissance électrique disponible est de 1.000 kVA. L'effectif de l'IRSID s'élève actuellement à 70 personnes et doublera rapidement. En attendant que ses laboratoires fonctionnent à plein, des travaux de recherches sont confiés aux laboratoires en activité de l'industrie, les écoles supérieures d'ingénieurs, les Universités. Parmi ceux-ci, un certain nombre, qui se sont tout fait connaître par des études de métallurgie physique, ont acquis une renommée mondiale. A part les études de R. Perrin, G. Chaudron, H. Malcor et G. Ra..., on trouve dans les publications françaises relativement peu d'études sur les équilibres chimiques. C'est là une voie dans laquelle l'IRSID se devra de donner une impulsion.

L'IRSID n'organise pas les Congrès et les Conférences comme font l'Iron and Steel Institute ou l'Instituto del Hierro y del Acero, par exemple; cette tâche revient à la **Société Française de Métallurgie.** La création de cette Société avait été projetée, en mars 1940, à la suite d'une mission qui avait pour but d'organiser la coopération franco-britannique, dans le domaine des recherches scientifiques et métallurgiques.

Cette mission était composée de M. A. Portevin, chef de la mission, et de MM. Chaudron, Chevenard, E. Dupuy, Nicolau, Rocard.

L'idée, laissée en sommeil pendant l'occupation, fut reprise en 1944, au lendemain de la Libération.

La Société Française de Métallurgie assure la liaison entre les savants et les ingénieurs métallurgistes, elle encourage les recherches de son domaine, organise les Congrès et les Conférences, et assure la publication des mémoires grâce à la *Revue de Métallurgie*, fondée en 1904, par Henry Le Chatelier.

La Société est administrée par un Conseil, dirigée par un bureau élu par lui et nommé pour un an, à l'exception du secrétaire général et du trésorier qui sont nommés pour trois ans.

Les présidents successifs ont été, depuis 1944, MM. R. Perrin, A. Portevin, A. Aron, P. Chevenard, P. Nicolau. Le secrétaire général est M. E. Dupuy.

Les liaisons avec les Instituts de Recherches et Centres Techniques des industries voisines, déjà établies par une collaboration étroite à propos de recherches sur des sujets d'intérêt commun, sont assurées, en outre, par la *Commission Permanente des Centres et Instituts de Recherches Techniques*.

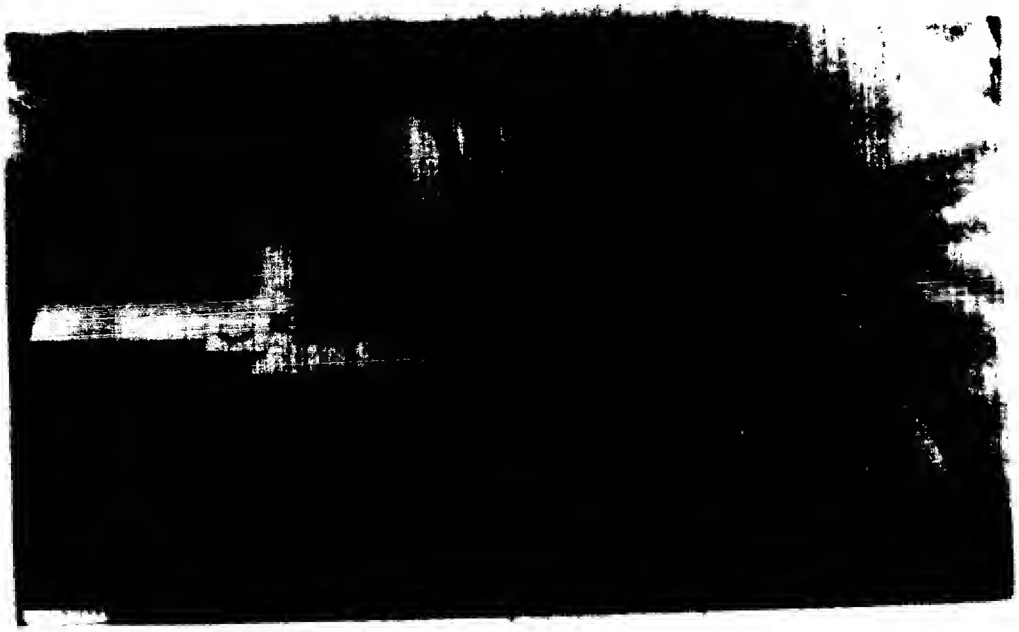

Fig. 6. — *Maquette des laboratoires de l'I.R.S.I.D.* (R. Coulon, architecte).

BELGIQUE

La Belgique possède un certain nombre de laboratoires universitaires s'intéressant très activement aux problèmes sidérurgiques, à Liège et à Mons notamment, mais aussi à Bruxelles, Louvain et Gand.

Les laboratoires de ses usines sont parfois très développés, aussi bien dans la sidérurgie lourde que dans la construction.

Sur le plan national, les recherches de sciences pures sont patronnées par le Fonds National de la Recherche Scientifique (F.N.R.S.), et celles de sciences appliquées [illegible] *Institut* [illegible] *l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture* (*I.R.S.I.A.*).

Les industriels, en majorité de la métallurgie, ont créé en date du 11 mars 1948, le **Centre National de Recherches Métallurgiques** (C.N.R.M.) sous la forme d'une association sans but lucratif, largement dotée des subsides de l'I.R.S.I.A. Le C.N.R.M. est ouvert à toutes les entreprises industrielles de production, transformation et utilisation des métaux ferreux et non ferreux.

Les frais de fonctionnement du C.N.R.M. sont couverts par les cotisations des sociétés-membres [illegible]

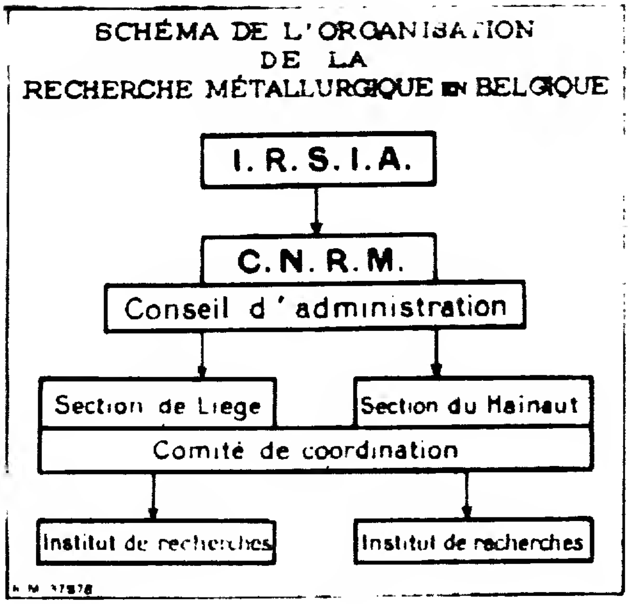

Fig 7

fixées au prorata de la production et du nombre d'ouvriers par le Conseil d'Administration et qui ne peuvent pas dépasser 1/2 pour mille du chiffre d'affaires.

Les frais de recherches proprement dits sont assurés par moitié par l'I.R.S.I.A., l'autre moitié étant à charge du C.N.R.M.

Le schéma de l'organisation du C.N.R.M. est donné dans la figure 7.

Le Conseil d'administration comprend treize membres, nommés pour deux ans, tous directeurs d'usines. Son Président est M. Perot, son premier vice-président est M. Decoux. Ensuite, l'organisation se dédouble en deux branches parallèles, correspondant aux régions industrielles des bassins de Liège et du Hainaut. Le président assume en même temps les fonctions d'administrateur-délégué de la Section de Liège et le premier vice-président assure la même fonction à la Section du Hainaut.

Le Comité technique de la Section de Liège est présidé par le professeur Thyssen, celui du Hainaut par M. Pivont. La liaison entre les deux sections est assurée par un Comité de Coordination formé des deux Présidents et des Directeurs respectifs des sections. Chaque section possède un organisme de direction des recherches. Celui du Hainaut est dirigé par M. Massinon, et celui de Liège par M. Coheur.

Bien que les deux sections n'aient pas de domaine réservé à chacune d'elles, il faut noter que la section du Hainaut s'est attachée surtout à l'étude physico-chimique des problèmes sidérurgiques, et notamment aux questions liées à la présence des gaz dans les métaux, tandis que la section de Liège est orientée davantage vers la physique des métaux.

ITALIE

L'industrie sidérurgique italienne est en grande partie nationalisée, mais pratiquement les usines Cogne, à Aoste, sont les seules qui aient été placées directement sous la gestion de l'État.

Dans les autres firmes sidérurgiques importantes, l'État n'a qu'une faible participation directe et n'agit que par l'intermédiaire de l'Institut de Reconstruction Industrielle (I.R.I.), contrôlant l'industrie au point de vue financier. Celui des organismes de l'I.R.I. chargé de la sidérurgie est le « **Finsider** », sous contrôle duquel sont placées les usines Ilva, Terni, Ansaldo (actuellement SIAC = Société Italienne des Aciéries de Cornigliano), Dalmine, Breda. Ces usines représentent 50 % de la production sidérurgique italienne.

Le Finsider a récemment décidé de créer un Centre de Recherches Sidérurgiques dont la direction a été confiée à M. le professeur Scortecci.

Parmi les laboratoires industriels les mieux outillés pour la recherche sidérurgique, citons l'Institut Scientifique de la Société Breda, occupant cent dix employés, dont quinze docteurs, et celui des usines Ansaldo. Ces laboratoires font déjà des recherches sous contrat, soit pour le Gouvernement, soit pour l'industrie. Les laboratoires de recherches de Novare, de la Montecatini, sont très importants. Bien qu'ils ne soient pas spécialisés dans la métallurgie, de nombreuses études sont faites par la division de physique des métaux.

L'Italie possède une « **Association de Métallurgie** » très vivante; son président est le Dr Dacco, et le secrétaire général le Dr Masi.

La liaison entre l'Université et l'Industrie est étroite. Des professeurs spécialisés dans des techniques ou services particuliers intéressant la sidérurgie, sont souvent chargés de diriger des sections de laboratoires industriels.

Un des gros soucis des dirigeants de la sidérurgie italienne est la formation des cadres supérieurs et de la maîtrise. On veut s'efforcer de relever le niveau de l'ingénieur pour le mettre à même de faire de la recherche et celui du chef de fabrication pour le rendre plus attentif aux progrès et aux techniques nouvelles.

TCHÉCOSLOVAQUIE

L'Industrie sidérurgique tchécoslovaque a été nationalisée après la deuxième guerre mondiale, mais non étatisée. Des groupes puissants d'industriels et de banquiers étrangers ou même ennemis avaient contribué au développement de l'industrie de ce pays. L'expropriation des mines au profit de la Nation les rendaient donc propriétés nationales, mais leur gestion devait conserver les principes de gestion des entreprises privées. En particulier, elles doivent se procurer par des crédits normaux le capital nécessaire à leur fonctionnement et à leur développement et payer les mêmes impôts que les entreprises privées.

Leurs employés ne sont pas fonctionnaires et sont soumis aux dispositions légales appliquées au personnel de l'industrie privée.

La sidérurgie tchécoslovaque constitue la septième section du Ministère de l'Industrie; elle comprend trois groupes sidérurgiques distincts, ce qui permet une certaine concurrence et une certaine émulation, ce sont : Vitkovice, Banska à Hutni et les Aciéries Réunies de Bohême.

La figure 8 donne le schéma de l'organisation de la « Direction de la Sidérurgie », du Ministère de l'Industrie.

La recherche sur les problèmes intéressant la sidérurgie était très développée avant la guerre dans les Universités, Écoles des Mines, Écoles de Fonderie, et les chercheurs tchèques tenaient une place importante dans les Congrès de Métallurgie internationaux. L'industrie possédait également des laboratoires importants et des chercheurs réputés.

Actuellement, la Tchécoslovaquie souffre d'une pénurie de cadres; ceux-ci étaient avant-guerre en grande partie étrangers; par ailleurs, la fermeture des Écoles et Universités pendant l'occupation allemande, qui fut longue et lourde, ne permit pas la formation de diplômés. Il en résulta que les cadres existants ont été astreints d'abord à un gros effort de reconstruction et d'exploitation; cependant, la recherche est toujours en grand honneur dans les écoles d'ingénieurs et doit se développer de nouveau sous l'impulsion d'un Institut National de Recherches Sidérurgiques en projet.

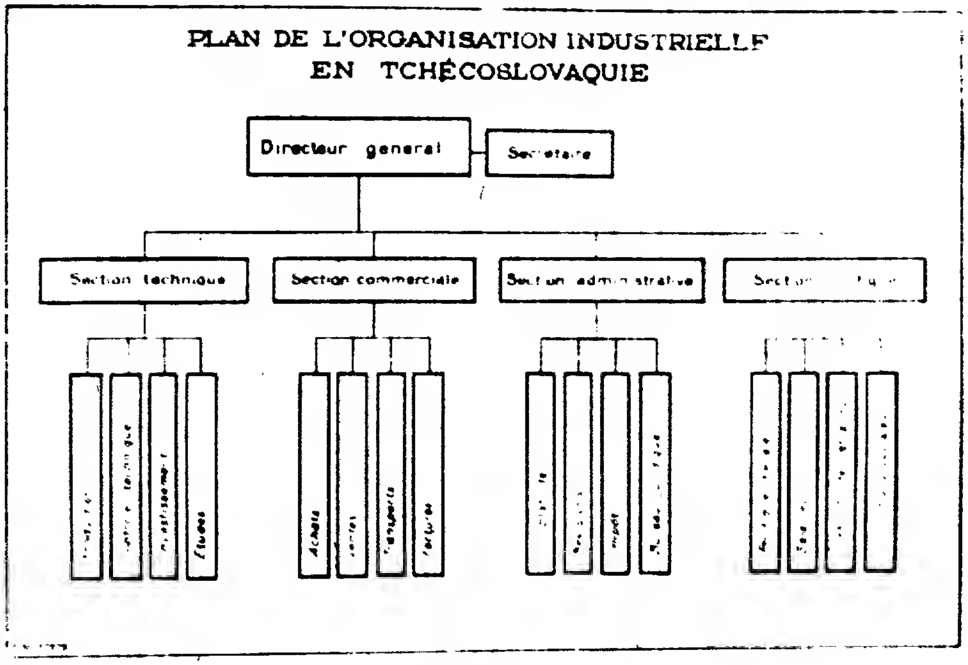

Fig. 8.

CANADA

Les principales Sociétés Sidérurgiques canadiennes sont : la Dominion Foundry and Steel Company of Canada, dont les hauts fourneaux produisent plus de 1.000 tonnes de fonte par jour, l'Algoma Steel, à Sault-Sainte-Marie, sur le Lac Supérieur, près de Duluth (Minnesota, U.S.A.) et la Doseo, à Sydney. L'usine de Welland dans l'Ontario, de l'Atlas Steel Limited, produit surtout des aciers inoxydables et des alliages spéciaux.

Le Canada ne possède pas d'Institut de Recherches Sidérurgiques proprement dit. Les recherches concernant les minerais de fer et les métaux ferreux sont faites principalement par le Bureau of Mines. Des recherches de base sont faites dans les Universités, en particulier à l'Université de Toronto, dont M. Cavanagh dirige la section sidérurgique. Cette Université possède un budget de 500.000 dollars et un effectif de 500 personnes; les recherches sidérurgiques représentent environ 30 % des

dépenses totales. Les Sociétés privées financent les recherches qui les intéressent, et l'État fournit une somme égale.

Le Bureau of Mines, organisme créé et subventionné par l'État, possède quatre cents employés, dont la moitié sont des techniciens. Son directeur est M. G. E. Pearsons. Il possède des laboratoires de métallurgie et notamment une division d'études de la transformation des métaux possédant un équipement moderne pour l'étude du laminage, du forgeage, de l'emboutissage et de l'étirage, du moulage et du soudage. On y pratique aussi la physique des métaux, sans compter l'établissement de l'inventaire des ressources minérales et de la [illegible] des minerais qui constitue sa tâche essentielle. Sa [illegible]thèque contient 50.000 volumes et 200 [illegible] techniques.

Les organisations syndicales d'employeurs [illegible] des commissions techniques comme celle de l'acier [illegible] par exemple, elles proposent des sujets d'études [illegible]lières aux laboratoires officiels. Enfin, les sociétés [illegible]tes en activité sont des filiales des grandes sociétés [illegible]niques américaines, comme l'American Society [illegible]tals et l'American Foundrymen Association.

SUÈDE

La Suède, malgré sa production relativement faible, possède, grâce à ses minerais purs et à la qualité de ses produits, une industrie sidérurgique importante. Elle exporte à l'étranger son minerai, ses fontes, son éponge de fer, des aciers de qualité.

L'Association des Maîtres de Forge suédois, le **Jernkontoret,** fondé le 29 décembre 1747, avait à l'origine pour objectif essentiel l'établissement des prix des produits d'exportation. Comme toute association syndicale patronale, elle est chargée des intérêts généraux de la profession. Ces intérêts, elle les a compris en donnant aux études techniques une importance primordiale.

Le Jernkontoret publie, en effet, depuis 1817, l'un des plus anciens périodiques techniques du monde, le *Jernkontorets Annaler*; il a aussi créé la première École des Mines de Suède, et il subventionne notamment l'École des Mines de Filipstad, l'École des Mines et de Métallurgie de l'Institut Royal de Technologie de Stockholm.

Les Services techniques du Jernkontoret sont dirigés par le Dr M. Tigerschiöld, assisté de l'ingénieur Sahlin, rédacteur en chef du Jernkontorets Annaler. Les études techniques sont suivies par six Commissions spécialisées, qui sont les suivantes :

1° Mines et préparation des minerais;
2° Fabrication de la fonte et de l'acier;
3° Forgeage et laminage;
4° Traitements thermiques et essais des métaux;
5° Economie de combustibles;
6° Fonderie d'acier.

Au début de chaque année, le Jernkontoret organise des réunions techniques au cours desquelles les rapports les plus importants sont discutés.

Les problèmes abordés, d'ordre pratique généralement, sont traités expérimentalement dans les usines et leurs laboratoires.

Les études fondamentales sont la plupart du temps traitées à l'Institut Royal de Technologie ou à l'[illegible] Métallographique, récemment créé.

L'Institut Métallographique de Stockholm, [illegible]rigé par le professeur Erik Rudberg, dispose d'un [illegible]get de 300.000 couronnes, dont 4/7 sont versés par l'industrie sidérurgique, 1/7 par l'industrie des [illegible] non ferreux, et 2/7 par l'industrie mécanique.

Les bâtiments ont été mis à la disposition de l'Industrie métallurgique par l'État.

Le Conseil d'administration comprend dix [illegible] dont sept sont désignés par l'Industrie et trois par le Gouvernement, sur présentation par les organisations [illegible]fiques et techniques. Un Comité d'Études, composé [illegible] techniciens éminents, appartenant aux industries [illegible]sées, aide le directeur dans l'établissement des [illegible]mes d'études.

Les laboratoires comportent deux bâtiments dont [illegible] halle de 500 m² et un laboratoire de trois [illegible] ayant au total une surface de 2.000 m². L'énergie [illegible]ponible est de 500 kVA.

L'effectif du personnel s'élève à trente unités dont [illegible] diplômés.

Les travaux de l'Institut sont pour la plupart [illegible] par les *Annales du Jernkontoret*.

Des recherches fondamentales et de sciences [illegible]quées sont faites depuis longtemps dans les U[illegible] et les Écoles des Mines et de Métallurgie; en particulier l'Institut Royal de Technologie de Stockholm [illegible] des divisions spécialisées dans l'étude des minerais, [illegible] la métallurgie, du fer et de l'acier, de la métallo[illegible]

Les noms de Benedicks, Wiberg, Hultgren, [illegible]gren, Mortseu, sont assez connus des métallurgistes [illegible] avoir une idée des travaux qui y sont faits et de l'[illegible] qui y est déployée.

Les usines, même celles d'importance moyenne, [illegible]dent aussi des laboratoires fort bien équipés et [illegible]pant activement à l'amélioration de la qualité des [illegible]duits. L'un des plus remarquablement installés, mais [illegible]tiquant peu la métallurgie, est celui d'Höganäs.

INDES

L'Inde possède de grosses réserves de houille et de minerai de fer. Elle est devenue un producteur relativement important de fonte. En 1940, elle en fabriquait 2 millions de tonnes, dont 600.000 tonnes étaient exportées. Cette exportation diminua au fur et à mesure du développement de la fabrication de l'acier. En 1945, la production de fonte était de 1,4 million de tonnes, dont moins de 200.000 tonnes furent livrées à l'exportation; la production d'acier s'élevait dans le même temps à plus de 1,5 million de tonnes, dont plus de 1 million de tonnes d'acier fin.

Les hauts fourneaux appartiennent à trois compagnies:

— la Tata Iron and Steel C°, à Jamshedpur (la plus importante) ;

— l'Indian Iron and Steel C°;

— la Mysore Iron C°, à Bhadravati (Inde méridionale).

La Steel Corporation of Bengal fait de l'acier à partir de la fonte produite par l'Indian Iron and Steel C°. Parmi les laminoirs et aciéries liés à la Tata C°, on peut citer l'Indian Tinplate C°, l'Indian Steel Wire Ltd., les Agrico-Implements Works, les Indian Steel Rolling Mills.

Un effort est fait pour assurer l'indépendance sidérurgique de l'Inde et l'établissement de nouvelles aciéries est à l'étude. Sur le plan des recherches scientifiques, un laboratoire central, le **National Metallurgical Laboratory** est en cours d'installation à Jamshedpur.

Sa première pierre a été posée le 21 novembre 1946, à Jamshedpur, sur un terrain voisin des usines et laboratoires de la Tata Iron and Steel C° et donné par cette Société.

Ce laboratoire est sous le patronage du Council of Scientific and Industrial Research, et il est dirigé par M. G. P. Contractor. Son financement est assuré par les industries sidérurgiques de l'Inde et, en particulier, par la Tata. Il comprend un bâtiment principal d'une superficie de plancher de 5.600 m², un atelier avec quatre halles d'une superficie totale de 1.440 m² et une halle centrale de 360 m².

AUSTRALIE

L'Australie, qui a une production d'acier appréciable, se préoccupe de coordonner les travaux de recherches opérés dans la métallurgie. Ce pays possède deux sociétés scientifiques importantes: The Australian Institute of Mining and Metallurgy, spécialisé dans les questions minières, de préparation des minerais et production de métal et l'Australian Institute of Metals, qui s'intéresse surtout à la transformation, au traitement et à l'utilisation des métaux, ainsi qu'aux problèmes de base qui les concernent.

L'Australian Institute of Metals est divisé en plusieurs sections locales réparties dans les principaux centres métallurgiques. Cette société compte 1.500 à 2.000 membres et continue à se développer. Les publications scientifiques étaient toutes faites auparavant dans l'*Australian Engineer*, mais ce bulletin est complété actuellement par un volume annuel de *Transactions* publiant les travaux présentés au cours des meetings annuels. Le secrétaire de l'Institute of Metals australien est M. R. S. Russell, à Melbourne.

JAPON

La production sidérurgique du Japon était, avant la guerre, d'une importance appréciable; la défaite de ce pays a réduit cette production au 1/7 environ de ce qu'elle était.

Le Japon possédait déjà, avant-guerre, un certain nombre de laboratoires de recherches et une Société savante pour l'avancement de la recherche scientifique créée en 1934, présidée par le D^r Nagaoka et placée sous le contrôle du Ministère de l'Education Nationale.

Les données essentielles relatives à cet organisme nous ont été fournies par le D^r Oketani. Cette Société comprenait de nombreuses commissions et sous-commissions spécialisées et notamment celles relatives à la production des aciers spéciaux, à la fonderie, aux fabrications d'aciers de blindage.

Le Conseil National de la Recherche dépendait du Ministère de l'Education Nationale et avait un caractère encore plus officiel. Il était présidé, en 1944, par le D^r Hayashi, professeur de l'Université Impériale de Tokio. L'effort de ces deux organismes était souvent mené en commun. Par contre, leur liaison avec le Centre Technique (Board of Technology), autre organisme officiel de création récente (1942), était beaucoup moins bonne.

Les renseignements qui suivent, relatifs aux associations techniques et aux laboratoires proprement dits, ont été puisés dans les comptes rendus des enquêteurs des U.S.A. qui occupent ce pays (*).

Parmi les Associations techniques, citons

l'Institut du Fer et de l'Acier,
l'Institut des Métaux,
l'Institut de Fonderie,
l'Institut de Soudure.

Les laboratoires se répartissent entre les Universités, les administrations militaires et l'industrie. On compte, en outre, un laboratoire privé important.

Les laboratoires universitaires les plus importants, ceux des Universités de Tokyo, Nagaya, Osaka, Kyoto, possèdent des départements de métallurgie qui se consacrent généralement aux recherches fondamentales. Cependant ces laboratoires ont fait pendant la guerre des recherches techniques, notamment sur les métaux de remplacement.

Les Universités possèdent aussi des Instituts spécialisés, comme l'Institut des Métaux de l'Université de Tohoku, à Sendai, le plus important des laboratoires métallurgiques du Japon. Il est dirigé par le D' K. Honda depuis 1915. Cet Institut comportait en 1944 deux cents employés, dont dix-sept professeurs et seize assistants. Les publications sont données dans les Science Reports of Tohoku Imperial University, en [illegible] en anglais.

L'Université de Tokyo possède un Institut [illegible] recherches Aéronautiques, et l'Université de [illegible] institut de Fonderie.

Les administrations militaires possèdent des [illegible] res de recherches métallurgiques, notamment à [illegible] Tachikawa et Tokyo. Ces laboratoires [illegible] par des officiers non spécialistes de la recherche [illegible] en vase clos et sans liaison avec les autres [illegible]

Une vingtaine de sociétés industrielles [illegible] recherche dans leurs laboratoires propres. [illegible] ci, la Japan Iron and Steel Company contrôle [illegible] de la production de l'acier du Japon et possède [illegible] ratoires à Tokyo et Yawata. Celui de Tokyo [illegible] quarante-quatre employés en 1944, celui de Y[illegible] cinq cent soixante-quatre.

Enfin, le Japon possède une organisation [illegible] recherches établie suivant le modèle du « Mellon Institute » américain, l'Institut de Recherches Physico-Chimiques. Celui-ci comprend trente-trois [illegible] dont quatre spécialisés dans la métallurgie et [illegible] les D' Iitaka, Mashima et Fuzii. Ces laboratoires possèdent le meilleur équipement qui soit, et un [illegible] de qualité.

Les savants métallurgistes du Japon sont de [illegible] internationale, mais rares sont les techniciens capables [illegible] les suivre dans le domaine des applications.

ESPAGNE

L'Instituto del Hierro y del Acero, espagnol, Villanueva 15, à Madrid, a été créé il y a moins de deux ans, sous l'égide du Conseil Supérieur des Recherches Scientifiques (Conseja Superior de Investigaciones Cientificas). Il est organisé à peu près comme l'Iron and Steel Institute de Londres, ne possède pas encore de laboratoires propres, mais fait promouvoir les recherches sidérurgiques en vue notamment de tirer le meilleur parti des ressources minérales du pays. Les recherches de laboratoires sont faites dans les laboratoires dépendant du Conseil Supérieur des Recherches Scientifiques, de l'Aéronautique ou de l'Armement.

Le directeur de l'Institut est M. A. Plana Sancho et son sous-directeur, M. I. Sans Darnis. On trouve, en particulier, parmi les principaux chefs de service, M. J. Navarro Alcacer, bien connu, en France, du monde de la fonderie.

Le personnel comprend actuellement un total d'environ quatre-vingt membres. Le schéma de l'organisation de l'Institut est donné dans la figure 9.

En premier lieu fut établi le service de la documentation, qui propose les sujets d'études, en tenant [illegible] des suggestions de l'industrie.

Les principaux problèmes proposés à l'activité de l'Institut sont :

1° Étude des gisements de minerais : minerais de [illegible] et minerais des métaux susceptibles d'être alliés au fer [illegible] vue de normaliser une production basée sur les [illegible] minérales du pays;

2° Étude de la préparation des minerais;
3° Étude des méthodes de fabrication;
4° Normalisation des méthodes d'analyses et d'[illegible]
5° Normalisation des profils des produits [illegible]
6° Mise au point des cahiers des charges.

L'Institut espagnol de l'Acier se propose également de collaborer avec les Instituts des industries [illegible] notamment pour la cokéfaction de la houille.

L'Instituto del Hierro y del Acero vient de [illegible] sa première assemblée générale (du 23 au 27 [illegible] bre 1948), qui a eu un réel succès. De nombreuses communications techniques et scientifiques ont été [illegible]

(*) *Metal Progress*, février 1947, pp. 273-290.

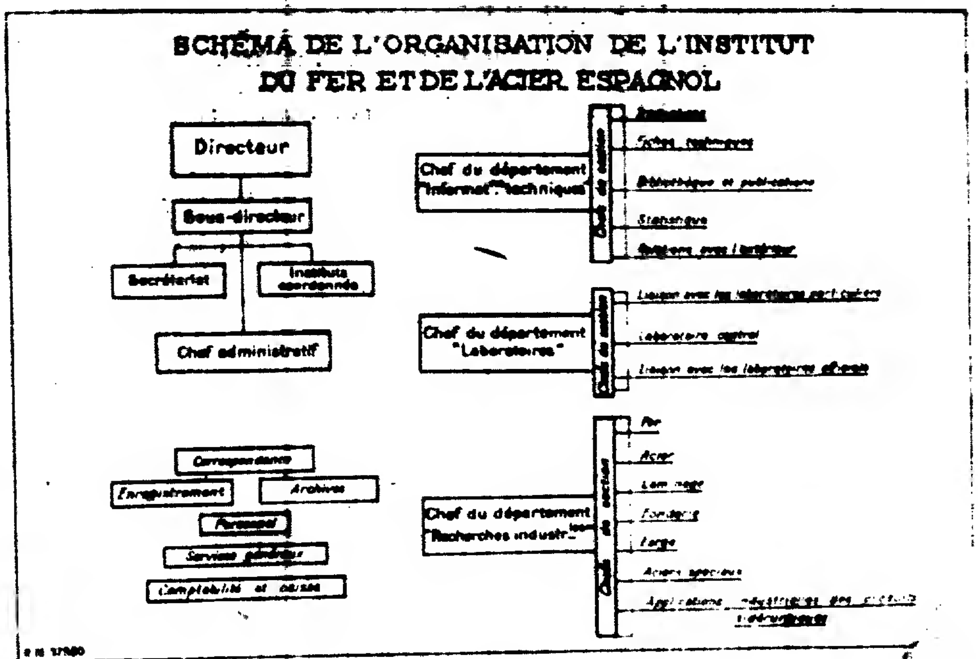

Fig. 9.

tées et discutées au cours des quatre journées de travail par des techniciens et savants espagnols et étrangers.

Le financement de l'Institut est assuré par un prélève- ment sur les produits … tuellement …

Ce tout petit pays n'est pas sidéru… réussi à s'imposer dans le domaine ind… lité de ses constructions mécaniques. L… niques sont aidées par leurs propr… ique des métaux, parfaitement…

Sur le plan national exi… d'Essai des Matériaux …

Après cette … ques, il nous rest… les organisation … Nous avons …

1° les Etats … deux colosses d… tés privées ou … en puissance … moyennes.

duction relativement faible, et leurs efforts tendus vers la fabrication de produits de qualité sont couronnés de succès. D'autres font un effort méritoire pour se rendre indépendantes de l'étranger, malgré la pénurie de leurs ressources naturelles ou l'insuffisance actuelle de leur équipement.

Aux Etats-Unis d'Amérique, existent au sein des sociétés privées des laboratoires centraux, véritables usines de recherches, dépassant en moyens d'action et en personnel les organisations nationales professionnelles des pays moyens. De plus, toute une floraison de laboratoires nationaux, universitaires, d'instituts techniques, de fondations de recherche travaillent pour le Gouvernement, pour l'industrie moyenne qui ne peut entretenir en permanence un laboratoire de recherches, et même pour l'industrie étrangère.

L'initiative privée a le champ libre, mais des liaisons sont établies en cas de besoin par des Comités créés pour la circonstance ou par les grandes Associations techniques.

En Russie, l'organisation étatique fait dépendre des divers ministères les différents laboratoires de recherches. L'Académie des Sciences dépend du Conseil des Ministres; elle contrôle en principe toutes les recherches d'intérêt national sur l'ensemble du territoire de l'Union.

Les Ecoles supérieures techniques sont soumises au Conseil scientifique de leur ministère respectif; les laboratoires industriels de recherches sont placés sous la direction du trust d'Etat dont ils ressortent et, par eux, sous le contrôle du Ministère de la Sidérurgie. Comme c'est le cas en Amérique pour la recherche sous contrat, les crédits alloués et la durée de la recherche sont précisés d'avance.

Par contre, les décisions relatives aux crédits, aux achats de matériel, à l'approbation des programmes, sont parfois lentes à venir : l'Administration exige pour se décider des prévisions parfois difficiles à donner. Ici, comme ailleurs, semble-t-il, le dynamisme des individus doit compenser les lenteurs administratives.

Dans ces deux pays, un même souci : « l'Efficiency », la recherche appliquée en vue de tirer le plus vite possible le meilleur parti des ressources nationales, d'intensifier la production et d'améliorer la qualité. La recherche pure n'est pas délaissée, mais les sommes affectées à son développement sont jugées trop faibles par rapport aux dépenses totales.

En Angleterre, en France, en Allemagne, existent des organisations ayant des points communs. D'un côté, les techniciens réunis dans des commisions ou comités sous l'égide des Chambres syndicales ou Fédérations industrielles comme l'Iron and Steel Federation, la Chambre Syndicale de la Sidérurgie française ou dans des [illegible] techniques comme l'Iron and Steel Institute, la [illegible] Française de Métallurgie, le Verein Deutscher Eisenhüttenleute, de l'autre, des organisations professionnelles de recherches comme le BISRA, en Angleterre, l'IRSID en France, le KWI en Allemagne, possédant leurs laboratoires propres, assurant la liaison entre l'Industrie et l'Université, et exécutant pour la profession ce que les sociétés privées n'ont pas le moyen de faire ou ne peuvent raisonnablement entreprendre seules. Ces organisations répondent à la structure industrielle de ces nations et à leur puissance sidérurgique; elles font à l'échelon de la profession ce que les sociétés énormes des nations [illegible] rées peuvent entreprendre par leurs propres moyens.

Dans les pays moins grands, ou moins favorisés par la nature, existent aussi parfois des organisations analogues, comme en Suède, où le Jernkontoret et son Institut Métallographique sont réputés. Aux Indes [illegible] se crée un Institut National de Recherches Métallurgiques, puissant au regard de la sidérurgie actuelle.

Dans les autres nations, Belgique, Tchécoslovaquie, Italie, Espagne, des instituts de recherches du fer et de l'acier se créent, ne disposant pas toujours de laboratoires propres, mais ayant la possibilité de diriger, de coordonner et de provoquer la recherche dans la profession. Dans ces nations, les institutions se font [illegible] blement à l'image de la grandeur du pays ou de la puissance de son industrie sidérurgique; elles seront [illegible] placées que quiconque pour améliorer les liaisons [illegible] l'industrie des pays voisins entre lesquels une collaboration étroite devient de plus en plus désirable.

Les institutions centrales presque toujours [illegible] tement ou indirectement de la profession pourront [illegible] tendance à incliner davantage vers les recherches d'application immédiate et ceci est juste : *Primum vivere*...

L'exemple est d'ailleurs donné par les fédérations d'Etats qui, malgré leurs puissants moyens d'action, [illegible] consacrent relativement trop peu à la recherche scientifique pure. Ne pas songer aux générations futures [illegible] pourtant une erreur, et des esprits avisés font remarquer que c'est grâce aux données accumulées pendant [illegible] temps par des chercheurs désintéressés que les formulaires d'ingénieurs ont pu être établis. L'étude des applications serait bientôt stoppée dans sa progression si des recherches de base n'apportaient pas à ces formulaires des données susceptibles de permettre des réalisations nouvelles.

Il faudra donc raisonnablement qu'une partie importante des disponibilités financières de la recherche [illegible] consacrée à la science pure, source naturelle de la science appliquée.